THE HEATING AND VENTILATING MAGAZINE

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AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Proceedings of Thirteenth Annual Meeting, New York, January 22-24, 1907

Under weather conditions that met every requirement of the heating engineer who does his figuring on a zero to 70° basis, the thirteenth annual meeting of the American Society of Heating and Ventilating Engineers was successfully held at the new Engineering Building, January 22-24, 1907. On the third day of the meeting the society opened its morning session with an outdoor temperature of zero, a point reached by the mercury for the first time this winter in New York.

The following members and guests attended the various sessions:

Homer Addams, Allentown, Pa.
R. Albertson, Atlantic City, N. J.
N. P. Andrus, New York.
Watson S. Anthony, Chicago, Ill.
Walter S. Appleton, New York.
A. S. Armagnac, New York.
Chas. G. Armstrong, New York.
E. L. Baker, New York.
William J. Baldwin, New York.
George W. Barr, Philadelphia, Pa.
Hugh J. Barron, New York.
Howard R. Barton, New York.
Thomas Barwick, New York.
D. Baumer, Johnstown, Pa.
H. E. Baumer, Johnstown, Pa.
Arthur Beucler, Bergenfields, N. J.
J. B. Bernhard, New York.
John Black, Trenton, N. J.
J. J. Blackmore, New York.
F. P. Blodgett, New York.
H. G. Boardman, New York.
Reginald Pelham Bolton, New York.
John Boylston, Chicago, Ill.
J. H. Brady, Kansas City, Mo.
John S. Brennan, Milwaukee, Wis.
N. S. Burnham, New York.
Frank B. Callister, Rochester, N. Y.
E. F. Capron, Chicago, Ill.
B. H. Carpenter, Wilkesbarre, Pa.
Raymond Carpenter, New York.
R. C. Carpenter, Ithaca, N. Y.
R. R. M. Carpenter, Wilmington, Del.
A. N. Chambers, New York.
Frank K. Chew, New York.
E. T. Child, New York.
R. T. Childs, New York.
George W. Clark, Newark, N. J.
Frank M. Commer, New York.
John A. Connolly, New York.
M. L. Corey, Argon, Ind.
H. D. Crane, Cincinnati, Ohio.
George H. Crawford, White Plains, N. Y.
Bert C. Davis, Kansas City, Mo.
James H. Davis, Chicago, Ill.
Edward B. Denny, Newark, N. J.
Robert C. Denny, Newark, N. J.
J. B. Dill, Jr., Indianapolis, Ind.
J. A. Donnelly, New York.
W. T. Donnelly, New York.
W. C. Doolittle, Utica, N. Y.
G. A. Dornheim, New York.
W. H. Driscoll, Jersey City, N. J.
A. C. Edgar, Philadelphia, Pa.
G. B. England, New York.
Charles H. Fay, Newark, N. J.
E. J. Febrey, Washington, D. C.
A. M. Feldman, New York.
John H. Foote, New York.
Albert B. Franklin, Boston, Mass.
Laurence Franklin, Boston, Mass.
C. G. Fundinger, New York.
Howard T. Gates, New York.
August Geiger, Philadelphia, Pa.
Henry B. Gombers, New York.
John Gormly, Philadelphia, Pa.
Charles E. Gorton, New York.
Joseph Graham, New York.
George L. Greenman, New York.
John F. Hale, Chicago, Ill.
J. M. Haller, Lancaster, Pa.

Richard Hankin, New York.
Andrew Harvey, Detroit, Mich.
Percy L. Hedrick, Chicago, Ill.
H. H. Hess, New York.
George D. Hoffman, New York.
C. S. Hopkins, New York.
B. N. Hurd, New York.
Louis J. Illig, Newark, N. J.
Stewart A. Jellett, Philadelphia, Pa.
George E. Jennings, New York
William E. Johnson, Warren, Ind.
Herbert A. Joslin, New York.
M. L. Kaiser, Wilkesbarre, Pa.
C. V. Kellogg, Chicago, Ill.
Alfred E. Kenrick, Brookline, Mass.
T. J. Kieley, New York.
Conway Kiewitz, New York
Raymond H. Kinnear, New York.
I. P. Kirk, Troy, N. Y.
Dr. J. M. W. Kitchen, East Orange, N. J.
J. George Klemm, Jr., Philadelphia, Pa.
J. D. Lahan, New York.
W. G. Le Compte, New York.
J. H. Lee, New York.
S. R. Lewis, Chicago, Ill.
C. C. Lincoln, Boston, Mass.
N. R. Lindemuth, York, Pa.
Philip Y. Linker, New York.
J. P. Lisk, Troy, N. Y.
W. W. Macon, Brooklyn, N. Y.
James Mackay, Chicago, Ill.
William M. Mackay, New York.
H. C. Mallory, New York.
Harry S. Martin, Dunkirk, N. Y.
Robert Mayo, Jr., Washington, D. C.
C. D. McArthur, New York.
Frank G. McCann, New York.
S. McCoy, Lancaster, Ohio.
William H. McKiever, New York.
Edward S. Molby, Frederick, Md.
Mark E. Monash, New York.
Charles Morrison, Boston, Mass.
H. F. Morsbingger, Somerville, N. J.
Otto E. Moske, Cleveland, Ohio.
John Mosner, New York.
George T. Mott, New York.
James H. Muett, New York.
William R. Munro.
E. K. Munroe, Baltimore, Md.
Thomas A. Nugent, New York.
Werner Nygren, New York.
Fred T. Oakes, New York.
George O'Hanlon.
E. J. Olmstead.
Millard P. Osbourn, Camden, N. J.
John A. Payne, Jersey City, N. J.
L. H. Quackenboss, New York.
W. H. Radcliffe, New York.
F. P. Richardson, New York.
C. L. Riley, New York.
Henry H. Ritter, New York.
William V. Rogers, Warren, Ind.
John P. Schaffer, Pittsburg, Pa.
N. C. Schroeder, New York.
U. G. Scollay, Brooklyn, N. Y.
Charles E. Scott, New York.
Winfield Scott, New York.
Percival H. Seward, New York.
J. R. Shanklin, Charleston, W. Va.
E. F. Singer, Brooklyn, N. Y.
O. P. Smiler, Johnstown, Pa.
H. A. Smith, New York.
Wm. G. Snow, Boston, Mass.
C. B. J. Snyder, New York.
B. F. Stangland, New York.
I. Stewart, Wilkesbarre, Pa.
George H. Stibbs, New York.
E. L. Stock, No. Tonawanda, N. Y.
E. R. Swan, Cedar Rapids, Ia.
William H. Switzer, Utica, N. Y.
R. Taggart, New York.
R. Barnard Talcott, New York.
C. Teran, New York.
Walter Thompson, Jersey City, N. J.
Alf. Tjersland, New York.
John C. F. Trachsel, Philadelphia, Pa.
C. P. Vanderveer, New York.
William C. Vrooman, Schenectady, N. Y.
William S. Washburn, Brockton, Mass.
Theodore Webster, Camden, N. J.
Warren Webster, Camden, N. J.
Fred J. Weeder, Rochester, N. Y.
Robert B. Wetmore, Buffalo, N. Y.
A. A. Wilson, New York.
H. A. Wilson, Boston, Mass.
L. J. Wing, New York.
Wiltsie F. Wolte, Philadelphia, Pa.
J. Young, Atlantic City, N. J.

First Day, Afternoon Session

The opening session was called to order by President John Gormly at 2.30 P. M. Tuesday. The secretary announced the following new members elected since the last meeting:

MEMBERS

John R. Allen, Ann Arbor, Mich.
Albert Aschaffenburg, New Orleans, La.
Arthur H. Barker, Woodcroft, Trowbridge, Wilts, England.
Frank H. Chisholm, Chicago, Ill.
George H. Crawford, White Plains, N. Y.
Edward D. Densmore, Boston, Mass.
J. Prator Dugger, Chicago, Ill.
George M. Getschow, Chicago, Ill.
Edward B. Gordon, Jr., Chicago, Ill.
William C. Green, Cincinnati, Ohio.
Fred K. Houston, Rockford, Ill.
Frank N. Jewett, Chicago, Ill.
George H. Kirk, Chicago, Ill.
John H. Kitchen, Kansas City, Mo.
Foster W. Lamb, Chicago, Ill.
Edwin A. May, Chicago, Ill.
Charles D. McArthur, New York.
Chas. F. Newport, Chicago, Ill.
Edward J. Ryan, Danville, Ill.
John J. Spear, Chicago, Ill.
Thomas Tait, Omaha, Neb.
Alvin W. Varney, Detroit, Mich.
Theo. Weinshank, Indianapolis, Ind.
Harvey R. Willard, Chicago, Ill.
William C. Wolf, Elkhart, Ind.

ASSOCIATE MEMBERS

James H. Martin, Jr., Chicago, Ill.
Lloyd G. McCrum, New York.
Mark E. Monash, New York.
William M. Scudder, Chicago, Ill.

JUNIOR MEMBERS

Norman A. Hill, Philadelphia, Pa.
Harry J. Ott, Chicago, Ill.
Alf. Tjersland, New York.

The reading of the roll call was dispensed with and the President's address followed, being characterized by all who heard it as a masterly effort that will take high rank in the society's literature. Following is the main portion of the President's address:

President's Address

In the name of the American Society of Heating and Ventilating Engineers I extend to you all a most hearty welcome to this, our thirteenth annual meeting. I trust you will take part freely in our deliberations, because an interchange of opinions and experience is beneficial to all. Aristotle says: "Were it not for an interchange of good-fellowship and acts of mutual kindness society could not exist."

THE POSSIBILITIES OF THE FUTURE

We aspire to be called a practical people, yet we spend millions to attain a theoretical North Pole, which, were it attained, would be utterly useless. At the same time we neglect to extract from nature the heating elements which it contains; which it not only contains but manifests to us, and which, if utilized, would not only warm us, but would drive all our power machines to the end of time. If we hold our faces in the future to the commercial grindstone, as we have done in the past, we will never attain that scientific perfection in heating and ventilation which will abolish the hot-air furnace, the steam and hot-water heaters, the radiators, the ashes, the smoke, and the wasted energy of our present cumbrous and expensive systems. The art of heating is in its infancy. It will stay there forever unless we tear ourselves from the rut into which we have fallen.

DRAWING HEAT FROM NATURE

Let us investigate how the sun maintains its heat for millions of years undiminished in intensity, and let us place smaller suns in every room to radiate heat as our sun does, directly, without cumbrous appliances, without pipes, valves, heaters, which, scientifically speaking, are but little advanced from barbarism. Were we scientific to the extent that we are commercial we would be drawing from nature's inexhaustible source of heat directly as the sun does. A perpetual and inexhaustible supply of heat drawn directly from the elements of nature is not an impossibility, nor is the attainment of such perpetual heating so far from us, if we will make an earnest effort to secure it. We must think, investigate and attain. It is a burning disgrace that our heating methods are so crude, so unscientific. We act as though we entirely neglect our intellectual nature to cater to our material nature.

WATER AS A SOURCE OF HEAT

We are just on the borderland of scientific heating. We know, from the investigation of our forbears, that water is composed in great part of oxygen, supplied in unlimited quantities by nature, yet we use water, not as a source of heat, but to transmit heat, much as we would use a freight car. It should be a source of heat, and would be were we scientists. Wonderful progress has been made in the study of electricity and magnetism. This should be an incentive to us. Will our future heating engineers utilize the electric powers of nature, which are so saturated with fire that they paint the heavens from the horizon to the zenith with the fiery flames of the aurora and appeal to all scientific engineers for investigation and utilization. Will we not in future mitigate the rigors of our winter by at least utilizing the millions of units of the sun's heat which so oppress us in summer? Those of us who envy the very rich may become richer than all others if we will perfect a modern system of heating which will extract its caloric energy from the fields of nature which are so prolific of possibilities. We should supply heat much as the arc light supplies illumination.

THE STORING OF HEAT

Our electric engineering brethren have succeeded in storing electric power in cells, to be liberated as desired. Is it more difficult to thus store heat rays, to be liberated as required? We are already so far advanced that we can concentrate the rays of the sun so they will melt refractory metals. Have any of us experimented with a view to the storage of these rays for future utilization? Is it more difficult than storing power? Yet that is already accomplished. We are wedded to our old methods as Ephraim was wedded to his idols. History tells us that at the siege of Syracuse, many years ago, the besieging fleet was burned at a great distance from the port by a scientist, who concentrated heat rays upon it. Is it possible that these people held the secret which we seek—namely, how to concentrate heat rays cheaply and to direct them to the point desired by simple appliances? It would look as though the ages which have preceded us were more scientific than we can truthfully claim to be.

GENERATING FORMULA OF THE SUN'S HEAT

Astronomers tell us that the sun, as seen through a whirlpool of its own vapor, is not heated even to redness; that it is a dark body. We must infer from this that the rays which it darts into space are heated by the effect of our atmosphere upon them, which transforms them into heat rays as they travel toward us. Could we but discover the generating formula of the sun's heat we would be far on the road to successful,

scientific heating. The time cannot be far distant when the forces of nature will be so understood and utilized that heat rays will be as dirigible as electric forces now are in the transmission of wireless telegrams. We utterly fail in our duty when we devote our energies to the commercial feature of heat transmission, to the entire neglect of scientific investigation. One hour each day devoted sacredly to scientific investigation by each member of our society would hardly bankrupt us, and would make us rich intellectually.

ADVANCES IN OTHER BRANCHES OF SCIENCE

The electric engineer and the chemist are forging ahead, and will overlap our field of duty if we neglect it. See and admire the giant strides the electric engineer has made. Note well how the chemist now extracts in one-half hour all the gold and silver contained in the most refractory ores, yet one year ago it took ninety days to extract 80 per cent. of its value. Other branches of science are advancing. We must advance or we must recede; there is no intermediate position. The time is ripe to relegate to ancient history the hot-air furnace, the steam heater, the water heater, with all their cumbrous appendages, which at best utilize but a fraction of the heat units they should transmit. We are part of a progressive age. Let us think more and struggle to attain a higher plane, which is ours if we but make the effort. The forces of nature which we could utilize almost overwhelm us. The outlines of continents are changed by volcanic action. The active power of volcanoes is uncontrolled heat. Each summer storm fills our atmosphere with sheets and bolts of fire, yet we look on as a horse or an ox might do, without an effort to harness these forces. We are for months so oppressed with excessive summer heat that we flee to the mountains for relief, yet we make no motion to utilize this excessive summer heat that we may mitigate the rigors of the winter which is sure to follow. If the excess of heat were stored, as electricity is stored, we might laugh the wintry blizzards to scorn. Do any of you imagine it is beyond the possibilities to store it and to liberate it as needed? We are as infants in our chosen profession; we will be the joke of future generations for coming so near perfection in heating without attaining it.

MORE PAPERS SHOULD BE PRESENTED

Another matter calls loudly for our very serious attention. If you will read the history of our society in its incipiency you will see in our printed proceedings that when we had but 75 members we had an abundance of good papers presented for discussion. You will also note that with four times that membership we now have no more papers than were first presented. What must we infer from this? Either that our present members are four times as indolent, or that they are four times as incompetent, or that they have but one-fourth the interest of the first members. This condition of affairs is so radically wrong that its cause should be discovered and eradicated.

You will also note that the principal papers presented, year after year, are by the same heroes who contribute freely of their time and talent. These men are worthy of much greater consideration than they have ever received. I would suggest that in all future lists of the names of our members those who have presented a paper, which has been accepted by our society, shall be printed in small capitals, and those who have not so distinguished themselves shall be printed in small letters. Such a distinction may spur those on who never do anything; those who absorb information, but give nothing. It will then be seen at a glance who are workers and who are not. It can work no injustice, for all members will receive just what they deserve. If they desire to be on the roll of honor they have but to present one acceptable paper.

The most onerous task connected with office in this society is to secure from members a few papers twice a year to be read. Members should vie with each other to crowd the society with papers. One would suppose from the answers returned when members are asked to contribute a paper on a subject which they have made a special study, that no member has time to eat more than one hurried meal a day. The facts are that no member is so pursued by the furies of financial disaster that the few hours needed in twelve months to prepare a paper would reduce him to bankruptcy. It is not the lack of ability; it is not the need of time; it is absolute indifference; or, worse, a desire to secure professional information and to give none in return. It is discreditable from any point of view.

VALUE OF REPORTS UPON UNSUCCESSFUL HEATING SYSTEMS

With a desire to remedy the evil I thus draw attention to it and suggest a remedy: Is it not plain that if all our members were to act in this selfish manner we could not exist as a society? It is vital to our success that a majority of members be active and efficient. If our members will but chart and tabulate the results they have attained with various systems of heating, noting the failures as freely as they note the successes with the bravery displayed by the surgical profession in publishing their failures as freely as they publish their successes, our proceedings would then be of incalculable benefit to their possessors.

At present we have but little of such information between the covers. What a showing we could present if each member were to chart from one to five such plants, regardless of the success or failure! Have you the nerve to do it? Our charter states that we are associated for the promotion of the arts and sciences and for the interchange of knowledge. Every honest means toward that end should be encouraged.

EXCHANGE OF PROCEEDINGS WITH KINDRED ENGINEERING SOCIETIES

The thought has been advanced that we might establish a form of exchange by which we would give copies of our proceedings to members of kindred engineering societies, and receive from them an equal number of copies of their printed proceedings for distribution among our members who desire to secure them. A very small advance above the cost to print and mail such publications might be charged. This charge should be paid by the member receiving such publication. The amount of money to be invested by any one would be slight. If a small addition to the actual cost were charged it would be a source of revenue to the society. When the forms are ready to print the extra cost of printing and mailing a few hundred additional copies would be but little. It is likely many of our members would gladly pay this cost to secure the proceedings of other kindred societies, and they would have many members who would be pleased to receive ours for a small fee.

I congratulate you on the fact that this society has prospered wonderfully the past year. This you will learn in detail from the reports of the treasurer and the secretary.

Secretary William M. Mackay then presented his report as follows:

Report of The Secretary

At the last annual meeting our membership was composed of 1 honorary member, 217 members, 17 associates and 8 juniors, or a total of 243 members of all grades.

During the year we have added 37 members, 6 associates, and 5 juniors, 1 associate was advanced to full membership, 2 members resigned, 1 junior failed to qualify, 5 members, 2 associates and 1 junior were dropped from the roll for nonpayment of dues, and one member, Mr. Herbert W. Nowell, who was elected to membership June 25, 1904, died on March 25, 1906.

Our present membership is 1 honorary member, 247 members, 20 associates and 11 juniors, or a total of 279 members of all grades, making a net increase of 36 during the past year.

The financial affairs of the society are in good condition. At the last annual meeting there was a balance in the hands of the treasurer of $633.94. We have received from all sources during the past year $3,710.62 which, with the balance on hand, made a total of $4,344.56 available.

The total expenditures amounted to $2,549.66, leaving a balance in the hands of the treasurer of $1,794.90. There is a balance owing from members for dues, etc., and from newly elected candidates for membership, for initiation fees and dues, amounting to $561.25; this with the balance on hand amounts to $2,356.15.

The members dropped from the roll during the year owed the society $240.

The 1905 proceedings, which were delayed for a number of reasons, have been completed and will be forwarded to the members at once.

The 1906 proceedings are well under way and will be printed as soon as the corrected discussion is returned by the members. The total cost of these two years' proceedings will be about $1,925. We have no unpaid bills on hand.

The secretary's expenses for the year, including stenographer, clerk hire, rent of post-office box, certificates, pin badges, expenses in connection with the summer meeting, postage, expressage, etc., amounted to $905.82.

The society held a summer meeting at Chicago, July 19th and 20, 1906, which was the largest and most successful meeting it has ever held.

The papers for this meeting were late in being received. There was a delay in having the cuts prepared. The papers were received from the printer's Monday afternoon and were immediately mailed to the members. Two papers will be read from manuscript.

The delay in receiving the papers prevents the possibility of the members obtaining a knowledge of them and consequently prevents a full and intelligent discussion of them, thus lessening their value, and I would urge on the members the desirability of sending in their papers earlier.

The Treasurer's report presented in detail the figures summarized in the Secretary's report. This was followed by the Board of Governors, which was read by Vice-President C. B. J. Snyder as follows:

Report of the Board of Governors

The Board of Governors met and organized on January 18, 1906, appointing committees on finance, membership and publication and an executive committee. The various committees have given careful attention to their duties and the board has met as often as was found necessary during the year. We are able to report a substantial increase in membership and the financial affairs of the society are in good condition, with sufficient funds on hand to pay for the two volumes of proceedings which will be

issued, one this month and one in three months.

A successful summer meeting was held at Chicago, July 19 and 20, 1906, at which it was voted that a change be made in the constitution to provide for local chapters of the society and that, if the members voted favorably on the amendment, permission be granted to the Illinois members to form a local chapter, with headquarters at Chicago. A vote was sent out October 30, and 103 votes were cast, 91 being in favor and 12 against the amendment. In accordance with the resolution, permission was granted to the Illinois members, who formed a permanent chapter on December 3, 1906.

We would call your attention to the fact that one-tenth of the membership is from abroad and but one foreign member has been honored by election to any office in the society, so that, if deemed advisable, action may be taken to give further recognition to our foreign supporters. We regret the delay in getting out the papers for this meeting, but it was unavoidable, owing to the late date some came to hand. Some matters were left over for this board to dispose of, and they have had very careful consideration, with final action in accordance with the best interests of the society and within the powers conferred by the constitution and by-laws. The request that the board look into the work of the fire protection association, which has its headquarters in Chicago, was referred to Vice-President T. J. Waters and the Chicago members, who have investigated the matter and recommended that no action be taken. The board has arranged for the trade press to have access to the stenographer's report of the meetings, subject to the corrections of the secretary.

(Signed) John Gormly, chairman; C. B. J. Snyder, vice-chairman; T. J. Waters, R. C. Carpenter, James Mackay, Frank K. Chew, B. F. Stangland, A. B. Franklin, W. M. Mackay, secretary.

REPORTS OF STANDING COMMITTEES.

For the Committee on Compulsory Legislation, the Chairman, T. J. Waters, being absent, James Mackay stated that an effort was being made to pass a ventilation law in Illinois, and a Denver member was also in communication with the committee with reference to passing a similar law in Colorado.

Owing to the late arrival of the report of the Committee on Standards, which dealt largely in figures, its presentation and discussion were put off to a later time.

The Committee on Tests reported the results of an elaborate series of tests on radiators to determine their relative heating capacity. The report was read by Prof. R. C. Carpenter.

REPORT OF SPECIAL COMMITTEES.

For the Committee on Standard Sizes of Steam and Return Mains, the Chairman, James A. Donnelly, submitted the following report:

REPORT OF COMMITTEE ON STANDARD SIZES OF STEAM AND RETURN MAINS

The Committee on the Standard Sizes of Steam and Return Mains beg to submit the following report, to be presented to the society through the Committee on Standards:

As we have received but one answer to the list of questions sent out since the summer meeting, and as that answer did not materially change the average compiled at that time, they regret to report that they have no additional data to add to their preliminary report.

In regard to the recommendation of a standard, their investigations have led them to the conclusion that the use of such a velocity as will require a difference of pressure of not more than one ounce to one hundred feet in straight pipe to maintain it represents, as near as they can at present ascertain, the best average practice in proportioning the sizes of steam and return mains.

For the Special Committee on Hot Water Heating, the Chairman, James Mackay, stated that two of the other members of the committee, S. R. Lewis and E. F. Capron, had done so much work in connection with the investigation that he would ask Mr. Lewis to read the report. It proved to be an exhaustive one and, acting on the suggestion of Prof. Kent, Chairman of the Committee on Standards, to whom a copy had been sent, it was decided to postpone the adoption of the report until it had been further revised. It was voted, however, to print the report for the purpose of further discussion at a subsequent meeting. It was also voted to continue the committee.

For the Committee on the Collection of Data on Steam Heating of Small Buildings, the Chairman, J. J. Blackmore, reported that the information collected, most of which was presented at last summer's meeting in Chicago, had been forwarded to Prof. Kent, Chairman of the Committee on Standards. It will be presented at another meeting. The committee was continued.

The President named as tellers W. S. Washburn, J. H. Brady and George B. England, to count the votes for the nominees and report at the evening session.

At this point Secretary Mackay announced that President Frederick R. Hutton, of the American Society of Mechanical Engineers, had accepted an invitation to be present at the annual dinner of the society the following evening. It was also announced that an inspection of the heating and ventilating plant of the New Engineering Building would be made the

following morning, and that E. T. Child, of G. A. Suter & Company, the contractors for the work, would accompany the party on its tour of inspection.

Under the head of New Business, a short discussion ensued relative to the recommendation that foreign members be represented on the Board of Governors; also the matter of the society contributing $50 toward the formation of new chapters. In the course of the remarks it was brought out that the English members have under consideration the organization of a local chapter of the society in England.

First Day, Evening Session

Upon the convening of the evening session, William S. Washburn, for the tellers, announced the result of the vote as follows:

NEW OFFICERS

President, C. B. J. Snyder, New York.

First vice-president, James Mackay, Chicago.

Second vice-president, William G. Snow, Boston.

Secretary, William M. Mackay, New York.

Treasurer, U. G. Scollay, Brooklyn, N. Y.

Board of Governors: Prof. R. C. Carpenter, Ithaca, N. Y.; Robert E. Atkinson, Leicester, England; Frank K. Chew, New York; Edmund F. Capron, Chicago, and Albert B. Franklin, Boston.

The first paper on the programme was then read, entitled:

Standard Sizes of Return Mains

By James A. Donnelly

(This paper was published in the January issue of THE HEATING AND VENTILATING MAGAZINE.)

On suggestion of Prof. Carpenter, the discussion of the paper was postponed until after the reading of the next paper on a similar subject.

The second paper on the programme was then read, entitled: "Flow of Steam in Pipes," by Prof. William Kent. This paper is published herewith.

*The Carrying Capacity of Pipes in Low-Pressure Steam Heating**

BY WILLIAM KENT

Professor William Kent

THE old tables for proportioning steam pipes to the amount of radiating surface supplied by them were based upon experience with small installations, where lines were short and radiating surfaces not extensive. They gave satisfaction generally, and while often they provided for larger sizes of pipe than were actually necessary, the saving of cost which might have been made by using smaller sizes was not enough to justify taking the risk of such smaller sizes not giving satisfaction.

In any case, a pipe should be proportioned for the worst set of conditions that are likely to be met. In the ordinary small installation the probability of frequent bad conditions is very great. Among them are occasional excessive steam demand in certain rooms, due to their being cold or to opening of windows; air-bound radiators; clogged returns; obstruction to flow of steam due to right angle bends and globe valves; low steam pressure due to excessive demand, to poor draft, to poor coal, or to fire poorly attended; insufficient supply of steam to some rooms, owing to insufficient or ineffective radiating surface, or to faulty pipe arrangements, causing short circuiting or easier flow of steam to some rooms than to others.

In modern practice many of these difficulties are greatly lessened. The wider experience of heating engineers and contractors has led generally to the provision of ample grate surface and heating surface in boilers, so that there is little probability of a deficient steam supply; and steam and return pipes are properly laid so there is less liability of obstructions to flow of steam or water. Installations are in general much larger than formerly, so that it is more important from the standpoint of first cost not to use pipes which are larger than necessary.

The time seems to have arrived when steam piping should be proportioned on a more logical basis than has been the custom heretofore. The following tables are offered as a contribution to this question. They are based on an assumed drop of 1 pound pressure per 1,000 feet of length, not because that is the drop which should always be used—in fact the writer believes that in large installations a far greater drop is permissible—but because it gives a basis upon which the flow for any other drop may be calculated, merely by multiplying the figures in the tables by the square root of the assigned drop. The formula from which the tables are calculated is the well known one $W = c\sqrt{\frac{w(p_1 - p_2)d^5}{L}}$ in which W = weight of steam per minute; w = weight of steam in

*Paper read at the Thirteenth Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

pound per cubic foot, at the entering pressure, p_1; p_2 the pressure at the end of the pipe; d the actual diameter of standard wrought-iron pipe in inches, and L the length in feet. The coefficients c are derived from D'Arcy's experiments on flow of water in pipes, and are believed to be as accurate as any that have been derived from the very few recorded experiments on steam. Should future experiments give more accurate figures the tables can be modified to correspond.

FLOW OF STEAM AT LOW PRESSURES IN POUNDS PER MINUTE FOR A UNIFORM DROP AT THE RATE OF ONE POUND PER 1,000 FEET LENGTH OF STRAIGHT PIPE.

Nominal diameter of Pipe, in.	Steam Pressures, by Gauge, at Entrances of Pipe. 0.3	1.3	2.3	3.3	4.3	5.3	6.3	8.3	10.3
	Flow of steam, pounds per minute.								
½	.070	.072	.074	.076	.078	.080	.082	.085	.089
¾	.161	1.66	.171	.375	.180	.184	.188	.197	.205
1	.317	.326	.336	.345	.354	.362	.371	.387	.403
1¼	.668	.688	.708	.728	.746	.765	.782	.817	.849
1½	1.023	1.054	1.085	1.114	1.143	1.171	1.198	1.250	1.300
2	2.013	2.075	2.136	2.191	2.250	2.305	2.358	2.462	2.560
2½	3.261	3.363	3.459	3.553	3.645	3.734	3.820	3.987	4.147
3	5.758	5.935	6.108	6.274	6.435	6.592	6.745	7.040	7.321
3½	8.421	8.680	8.932	9.175	9.411	9.642	9.864	10.30	10.71
4	11.69	12.05	12.40	12.74	13.07	13.39	13.70	14.29	14.86
4½	15.64	16.13	16.59	17.05	17.48	17.91	18.33	19.13	19.89
5	20.87	21.51	22.14	22.74	23.32	23.89	24.45	25.52	26.54
6	33.52	34.56	35.56	36.53	37.46	38.38	39.27	40.99	42.62
7	48.94	50.45	51.91	53.32	54.69	56.03	57.33	59.83	62.22
8	68.04	70.14	72.18	74.14	76.04	77.90	79.71	83.19	86.51
9	91.03	93.83	96.56	99.18	101.7	104.2	106.6	111.3	115.7
10	121.9	125.6	129.3	132.8	136.2	139.5	142.7	149.0	154.9
12	192.5	198.6	204.4	209.9	215.3	220.6	225.7	235.6	145.0

Formula $W = c\sqrt{\frac{w(p_1 - p_2)d^5}{L}}$

W = weight of steam, lbs. per minute; c = constant; w = weight of steam at pressure p_1 in lbs. per cu. ft.; $p_1 - p_2$ = drop in pressure, lbs. per sq. in.; d = actual inside diameter of pipe, inches; L = length in feet.

Nominal diameter of pipe	½	¾	1	1¼	1½	2	2½	3	3½
Value of c	36.8	42	45.3	48	50	52.7	54.8	56.2	57.1
Nominal diameter of pipe	4	4½	5	6	7	8	9	10	12
Value of c	57.8	58.3	58.7	59.5	60.2	60.8	61.3	61.7	62.1

For any other drop of pressure per 1,000 feet per length, multiply the figures in the table by the square root of that drop.

square foot of radiating surface per hour per degree of difference of temperature. This figure is approximately correct for several forms of both cast-iron radiators and pipe coils, not over 30 inches high and not over two pipes in width.

GENERAL RULE FOR PROPORTIONING STEAM PIPES TO STEAM RADIATING SURFACE

Given the number of square feet of radiating surface, the coefficient of transmission of that surface in British thermal units per hour (generally taken at 1.8, but may be greater or less than this according to the form of radiator), and the difference of temperature between the steam in the radiator and the temperature of the room ($T_1 - T_2$). Multiply the coefficient by the difference of temperature and by the number of square feet of radiating surface. This gives the total emission of heat in British thermal units per hour. Divide this by the latent heat, L, corresponding

FIGURES USED IN CALCULATION OF RADIATING SURFACE.

P = Pressure by gauge, lbs. per sq. in.									
0.	0.3	1.3	2.3	3.3	4.3	5.3	6.3	8.3	10.3
L = latent heat of evaporation B. T. U. per lb.									
965.7	965.0	962.6	960.4	958.3	956.3	954.4	952.6	949.1	945.8
Temperature Fahrenheit, T_2									
212.	213.	216.3	219.4	222.4	225.2	227.9	230.5	235.4	240.0
$T_1 = T_2 - 70$ degrees, difference of temperature									
142.	143.	146.3	149.4	152.4	155.2	157.9	160.5	165.4	170.0
$H_1 = T_1 \times 1.8$ = heat transmission per sq. ft. radiating surface, B. T. U. per hour.									
255.6	257.4	263.3	268.9	274.3	279.2	284.2	288.9	297.7	306.0
$\frac{H_1}{L}$ = steam condensed per sq. ft. radiating surface, lbs. per hour									
0.2647	.267	.274	.280	.286	.292	.298	.303	.314	.324
Reciprocal of above = radiating surface per lb. of steam condensed per hour									
3.78	3.75	3.65	3.57	3.50	3.42	3.36	3.30	3.18	3.09

The last three lines of figures are based on the empirical constant 1.8 for the average British thermal units transmitted per

to the steam pressure in the radiator. This will give the number of pounds of steam condensed per hour and the number of

FLOW OF STEAM AT LOW PRESSURES IN POUNDS PER HOUR FOR A UNIFORM DROP AT THE RATE OF ONE POUND PER 1,000 FEET LENGTH OF STRAIGHT PIPE.

Nominal diameter of Pipe.	Steam Pressures, by Gauge, at entrances of Pipe. 0.3	1.3	2.3	3.3	4.3	5.3	6.3	8.3	10.3
	Flow of steam, pounds per hour								
½	4.2	4.3	4.4	4.6	4.7	4.8	4.9	5.1	5.3
¾	9.7	10.0	10.3	10.5	10.8	11.0	11.3	11.8	12.3
1	19.0	19.6	20.2	20.7	21.2	21.7	22.3	23.2	24.2
1¼	40.1	41.3	42.5	43.7	44.8	45.9	46.9	49.0	50.9
1½	61.4	63.2	65.1	66.8	68.6	70.3	71.9	75.0	78.0
2	120.8	124.5	128.2	131.6	135.0	138.3	141.5	147.7	153.6
2½	195.7	201.8	207.5	213.2	218.7	224.0	229.2	239.2	248.8
3	345.5	356.1	366.5	376.4	386.1	395.5	404.7	422.4	439.3
3½	505.3	520.8	535.9	550.5	564.7	578.5	591.8	618.0	642.6
4	701.4	723.0	744.0	764.4	784.2	803.4	822.0	857.4	891.6
4½	938.7	967.6	995.8	1023.	1049.	1075.	1100.	1148.	1193.
5	1252.	1291.	1328.	1364.	1399.	1433.	1467.	1531.	1592.
6	2011.	2074.	2134.	2192.	2248.	2303.	2356.	2459.	2557.
7	2936.	3027.	3115.	3199.	3281.	3362.	3440.	3590.	3733.
8	4082.	4208.	4331.	4448.	4564.	4674.	4783.	4991.	5191.
9	5462.	3630.	5794.	5951.	6102.	6252.	6396.	6678.	6942.
10	7314.	7536.	7758.	7968.	8172.	8370.	8562.	8940.	9294.
12	11550.	11916.	12264.	12594.	12918.	13236.	13542.	14136.	14700.

pounds of steam that have to be conveyed through the pipe. Then from the table of flow in pounds per hour select the pipe which will carry that number of pounds with a drop of one pound per 1,000 feet of length. For any other assumed drop, divide the number of pounds of steam to be carried by the square root of the drop in pounds per 1,000 feet and then select from the table the size of pipe required.

HOW TO USE THE TABLES

Example: Required the size of pipe to supply 10,000 square feet of radiating surface when the entering pressure in the steam pipe is 4.3 pounds by gauge and is reduced by throttling at the entrance of the radiator to 1.3 pounds, assuming a drop at the rate of four pounds for each 1,000 feet of length of pipe, the coefficient of transmission of the radiator to be 1.8, and the temperature in the room 70 degrees.

Solution: Difference of temperature, 216.3—70 = 140.3 × 1.8 = 263.3 × 10.000 = 2,633,000 British thermal units per hour. Divide by latent heat 962.6 = 2,839 pounds per hour. According to the table at 4.3 pounds entering pressure this will be conveyed by a 7-inch pipe if the drop is only one pound per 1,000 feet, but for drop of 4 pounds, twice as much steam, 5,678 pounds per hour, would be conveyed by a 7-inch pipe.

Dividing 2,839 by 2 = 1,419, and this would be carried according to the table by a 5-inch pipe, the entering pressure being 4.3 pounds gauge. The 2,839 pounds therefore, will be carried by a 5-inch pipe with a drop of four pounds per 1,000. A 5-inch pipe is therefore the one to be selected for the 10,000 square feet of radiating surface, although according to the above table for radiating surface corresponding to given sizes of pipe it will only supply 4,732 square feet.

In all cases the judgment of the engineer must be used in the assumption of the drop to be allowed. For small distributing pipes it will generally be desirable to assume a drop of not more than one pound per 1,000 feet to insure that each single radiator shall always have an ample supply for the worst conditions, and in that case the size of piping given in the table

RADIATING SURFACE SUPPLIED BY DIFFERENT SIZES OF PIPE

On basis of steam in pipe at 0.3 pounds gauge pressure, steam in radiator 212 degrees, temperature of room 70 degrees. Heat transmitted per square foot radiating surface 255.6 British thermal units per hour, and drop of pressure in pipe at the rate of 1 pound per 1,000 feet lengths = pounds of steam per hour in precedingtable 1st column x 3.78.

Size of Pipe.	Radiating Surface, Sq. Ft.	WOLF'S TABLE FOR COMPARISON. (a) Pressure 2 lbs.	Pressure 5 lbs.
½	16	.....	.....
¾	37	.....	.....
1	72	36	60
1¼	152	72	120
1½	232	120	200
2	457	280	480
2½	740	528	880
3	1,306	900	1,500
3½	1,910	1,320	2,200
4	2,651	1,920	3,200
4½	3,558	2,760	4,600
5	4,732	3,720	6,200
6	7,602	6,000	10,000
7	11,098	9,000	15,000
8	15,430	12,800	21,600
9	20,646	17,800	30,000
10	27,647	23,200	39,000
12	43,659	37,000	62,000

(a)—Carpenter's Heating and Ventilating, p. 258.

up to two inches may he used; but if the main pipes supply totals of more than 500 square feet, greater drops may be allowed and calculations should be made as in the above example.

DISCUSSION.

PROF. CARPENTER: I think Prof. Kent is wrong when he says that heating engineers have not given these formulas for flow of steam very much consideration. I went over this thing a number of years ago and even before I touched it, Mr. Briggs, who presented a paper before a British Society, investigated the subject thoroughly. He used a formula practically the same as that of Prof. Kent, and I doubt if you can do very many things which cannot be done by that formula.

The tables given by Briggs are calculated for various steam pressures and for various losses of head, so that they cover very fully all the various conditions likely to rise in practice. Factors are given which can be used for other steam pressures than those given in the tables. In calculating the amount of steam for radiating surfaces, Mr. Briggs assumes that the amount of heat transmitted per square foot per hour in direct radiation is 1.8 per degree difference of temperature. This coefficient is the same that I understand was used by Mr. Kent. In accordance with this hypothesis, about ¼ of a pound of steam is condensed per hour under usual temperature conditions.

Mr. Donnelly's paper gives results which are computed from a slightly different formula from that used by Mr. Kent. Both the formulas used are accurate for the flow of water and probably not greatly in error for the flow of steam.

Mr. Donnelly's paper is interesting as giving a comparison of the results obtained by the use of various formulas. It serves to show that all the formulas give results through certain ranges which do not differ greatly, but for extreme positions there is a considerable variation. This rather serves to indicate that the use of any of the formulas will give results which are probably practically correct for ordinary application. When we consider that the resistance in every case is assumed, the agreement is probably closer with each other, so far as the tabular results are concerned, than the hypothesis adopted in applying these results practically.

A French engineer, Ledoux, made some extensive experiments on the flow of steam, from which quite accurate values of the coefficients in the theoretical formulas have been deduced. I at one time also checked up the value of these coefficients, obtaining essentially the same results. My own impression is that the flow of steam in pipes is most accurately represented by the following formula, of which the general form was first adopted by Professor Unwin, the coefficients having been determined by experiments:

Loss of head,

$$p = 0.000131\left(1 + \frac{3.6}{d}\right)\frac{w^2}{a\,d^5}$$

Discharge in lbs. per min.

$$w = 87.45\sqrt{\frac{p\,a\,d^5}{\left(3.6 + d\right)l}}$$

Diam. in inches $d = 0.184\sqrt[5]{\frac{w^2\,l}{p\,a}}$

In the above formula, p = loss of head in lbs., l = length of pipe in feet, d = diameter of pipe in inches, a = density of steam or weight per cubic foot as given in steam table.

A table of the flow of steam in pounds, published in the Babcock & Wilcox catalogue, agrees very closely with the above formula. This table is not, however, of much use to heating engineers, for the reason that the assumed pressure of steam is very high and the drop in pressure greater than allowable in good heating work.

R. C. TAGGART: Some time ago Mr. Baldwin and myself carried out certain experiments in order to determine with what velocity steam at about atmospheric pressure could pass through a pipe and still allow the water of condensation to readily return. Experiments were also made where air was forced up through a pipe, while water was falling in an opposite direction. The weight of the water and the weight of the air were made approximately equal. In other words, the relative weights of the gas and liquid were similar to what would be found in a one-pipe steam-heating apparatus.

The results of these experiments showed that in moderately large vertical pipes (3-inch and 4-inch pipes) it was possible for the velocity of the ascending steam to be as much as 50 feet per second without interfering with the return of the condensed steam as it falls down within the pipe. With smaller pipes the velocity of the ascending steam in vertical pipe risers should not exceed 30 to 40 feet per second; and in very small pipes (¾-inch and 1-inch), it is better to figure on a still lower velocity. It is possible, however, in quite small pipes, to obtain a velocity of 50 feet per second and still return the water of condensation under favorable conditions. Most of the experiments were made with pipes of relatively small diameters, and in the case of the 3-inch and 4-inch pipes, the experiments did not include velocities much above 50 feet per second.

In regard to the "drop" in pressure in one-pipe risers, I might say that the "drop" in pressure is of no particular importance, so long as we have pressure enough at each radiator for the steam to force out the air. Primarily, the size of

EQUALIZATION OF PIPES—UNWIN FORMULA (From James A. Donnelly's paper.)

	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	3½ in.	4 in.	4½ in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	12 in.	14 in.	16 in.
1 in.	1.	1.9	3.2	7.2	13.6	22.5	34.5	50.	68.7	91.4	150.	226.	322.	440.	582.	938.	1405.	1982.
1¼ in.		1.	1.7	3.8	7.2	12.	18.2	26.3	36.2	48.1	79.	119.	170.	232.	306.	494.	740.	1043.
1½ in.			1.	2.65	4.	7.	10.8	15.	21.5	28.6	47.	73.8	100.	138.	182.	293.	439.	650.
2 in.				1.	1.9	3.12	4.8	6.91	9.54	12.7	20.8	31.4	44.7	61.	80.8	130.	195.	275.
2½ in.					1.	1.65	2.54	3.68	5.05	6.72	11.	16.6	23.7	32.4	42.8	69.	103.	146.
3 in.						1.	1.5	2.22	3.05	4.06	6.7	10.	14.3	19.5	26.	41.2	62.4	88.
3½ in.							1.	1.45	2.	2.65	4.35	6.55	9.3	12.8	16.9	27.2	40.7	57.4
4 in.								1.	1.37	1.83	3.	4.52	6.44	8.8	11.6	18.7	28.1	39.6
4½ in.									1.	1.3	2.18	3.29	4.69	6.4	8.47	13.7	20.5	28.8
5 in.										1.	1.64	2.47	3.52	4.81	6.37	10.3	15.4	21.7
6 in.											1.	1.5	2.15	2.93	3.88	6.25	9.4	13.2
7 in.												1.	1.3	1.9	2.6	4.2	6.2	8.8
8 in.													1.	1.37	1.8	2.9	4.67	6.2
9 in.														1.	1.32	2.1	3.2	4.5
10 in.															1.	1.6	2.4	3.4
12 in.																1.	1.5	2.1
14 in.																	1.	1.4
16 in.																		1.

the vertical risers should be fixed by the velocity of the steam which may be allowed, rather than by the drop in pressure.

In gravity apparatus the loss in pressure in the main pipes must be comparatively small so as to allow the water of condensation to readily return to the boiler. A loss in pressure within a one-pipe vertical riser will not, however, prevent the water of condensation from returning to the boiler, provided the velocity of the steam within the pipe does hold up the return water.

[*Additional discussion of this subject by William J. Baldwin will be found on page* 32.]

TOPIC NO. 1.

Relation of Steam and Return Connections to Horse Power in Heating Boilers.

(There was no discussion on this topic.)

TOPIC NO. 2.

Size of Safety Valve for Heating Boilers Under Varying Pressures Up to Ten Pounds.

MR. MCCANN: The ordinary formula for low pressure heating would give normal sizes. For a 100 H. P. boiler, 25 square feet, the size would be 6 inches. I do not believe it should be over 3½ inches or 4 inches for that size of boiler. The formula is that required by the United States Government and also by Lloyd's and other insurance people.

Second Day, Morning Session

The morning was devoted to an inspection of the mechanical equipment of the new Engineering Building, in which the society was holding its meeting. A large party was conducted by Mr. E. T. Child, of G. A. Suter & Company, the contractors for the work. The inspection included a visit to the boiler, engine and fan rooms, and to the pent house on the roof.

Second Day, Afternoon Session

The first business on the programme at this session was the reading of a paper entitled "Temperature for Testing Indirect Heating Systems,' by W. W. Macon.

(Mr. Macon's paper is presented herewith.)

SUPPLEMENTARY REPORT OF COMMITTEE ON FURNACE HEATING.

In connection with Mr. Macon's paper, Mr. Chew called attention to the supplementary report of the Committee to Collect Data on Furnace Heating, which, he stated, had a bearing on the subject discussed by Mr. Macon. As this report was mainly a compilation of figures covering tests, it was voted to refer the report to the Board of Governors, to be printed if deemed advisable, together with a view to distributing the previous report on the subject for discussion at the next meeting of the society.

Temperatures for Testing Indirect Heating Systems*

By W. W. Macon

The object of this paper is to offer values of temperatures for use in testing indirect heating systems during periods when the zero weather conditions for which the system is designed are not existing. When a given indirect heating system is operated under the conditions which are expected to obtain in zero weather at a temperature out of doors that is something different from zero, a definite temperature within doors should be realized depending on the outdoor temperature.

The need of figures of this description has been expressed from time to time as something which will enable the contractor to assure the buyer of a system that the stipulations regarding the maintenance of a specified temperature in zero weather will be amply fulfilled. In other words it is stated that it should be possible to test a plant during relatively mild weather and from the results determine whether or not the plant has been properly designed, though the opinion is strong, in opposition to such a need, that acceptance of a heating plant should not be contingent on the results of a test, but should be independent of any such question at all, the reputation of the engineer sufficing to guarantee satisfactory performance until actually proved otherwise.

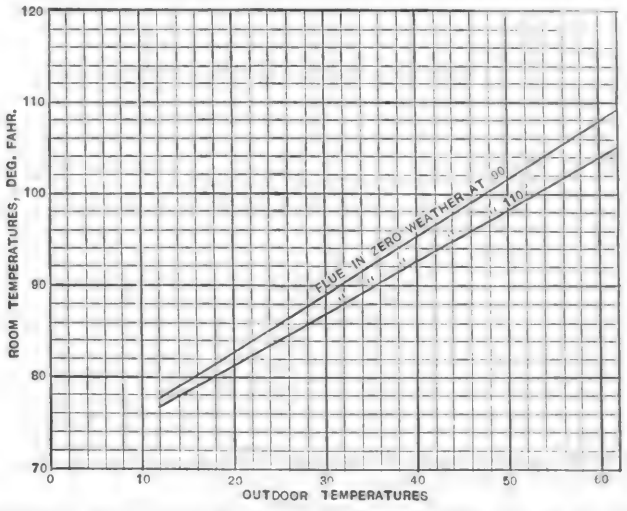
PREVIOUS PAPERS ON THE SUBJECT

As a contribution to the society's literature on the subject, the present paper is suggested as supplementary to the first paper presented to the first meeting of the society twelve years ago by Prof. J. H. Kinealy, entitled "Determining the Heating Power of Heating Systems," and as supplementary also to the "Code for Testing Direct Radiation Heating Plants," submitted by a committee of which Professor Kinealy was chairman, and printed in Vol. IX. of the society's "Transactions." Both Professor Kinealy's paper and the committee report treated solely of direct radiation, while the present discussion is designed to cover indirect radiation—steam as well as hot water, and, though with some question, the furnace system of warming. As an examination into the operation of indirect heating without reference to any application for testing work, the paper is submitted as continuing the subject treated in the society's initial paper.

CONSIDERATIONS INVOLVED IN DETERMINING TEMPERATURES

The considerations involved in the temperature determination are in brief as follows: When the indirect radiator heating medium, as steam or hot water, is turned into the radiator and the radiator starts emitting heat, the air immediately surrounding it becomes warmed. The result is an expansion of the air with consequent relative rarefaction or diminution in density.

The air outside being heavier per given volume and both inside and outside are being under atmospheric pressure, the weight of the outside air overbalances that inside and the warmed air is pushed upward. The cooler air in the process of displacement then becomes

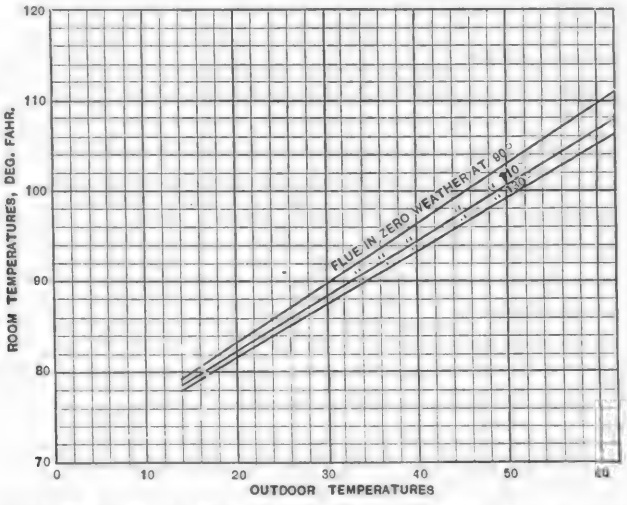


INDIRECT HOT WATER RADIATION—WATER AT 160 DEGREES

*Paper read at Thirteenth Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

warmed and the column of warm air becomes higher, so that the force, though actually small as compared with other forces encountered in engineering, becomes greater, resulting in successively higher velocities.

When the flue from the radiator becomes filled with warm air, the tendency for the speed to keep on increasing will be finally checked by the fact that the increases in speed result themselves in a lowering of the temperature and thus in turn in a lowering of speed. As the air



INDIRECT HOT WATER RADIATION—WATER AT 180 DEGREES

passes over the indirect heating surface the temperature which it attains is dependent on the speed, the higher the speed the less the final temperature (though the amount of heat absorbed increases). The air thus assumes a definite temperature which in connection with the outside temperature results in a definite velocity of flow, and this in turn results in the passage over the radiator in a given time of a definite quantity of air, and it is this quantity of air which the radiator is able to heat to the temperature in question. In short, an equilibrium among velocity, heat emitting capacity and outside and flue temperatures becomes established.

The first stage in the calculations required the determination of this flue temperature and had to take into account the varying amounts of heat that an indirect radiator will give off according to the speed of the air over it and the varying capacity for heat of a given volume of air depending on its density or weight per cubic foot.

The second stage of the calculations comprised the determination of the temperature a room would attain for a given outside temperature with the apparatus operated as though zero weather were at hand, use being made of the value of the flue temperature calculated in the first stage. The flue temperature in question will bring about the delivery into the building of a definite amount of air, which, heated from the outside temperature to the flue temperature, means the delivery of a definite amount of heat in a given time.

Before the amount of air involved in the particular case has succeeded in escaping from the building after delivery to the rooms, the temperature of the air is decreased from the flue temperature to a temperature within the rooms that is the temperature sought in the second stage of the calculations. In cooling from the flue temperature to this room temperature the air loses a definite amount of heat which is the amount that the exposed walls and windows of the rooms can carry away under the temperature difference between the inside air and the outside air.

RESULTS AND THEIR APPLICATION

Before explaining the operations involved in the calculations of both the first stage and the second stage, reference may be made to the results and to their application. Six different conditions of the indirect radiator were first considered in solving for the values of the different temperatures, three for steam indirect radiators and three for hot water indirect radiators.

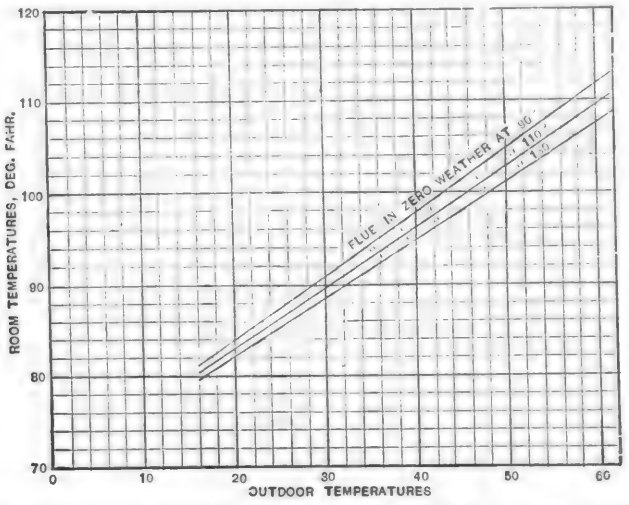
In the case of the steam radiators, the use in the radiator in zero weather of steam at 5 pounds above the atmosphere was considered and steam at about 2 pounds above the atmosphere and at atmospheric pressure, in other words the use of steam at 227°, 218° and 212° respectively. In the case of the hot water radiators three temperatures of water were selected, 200°, 180° and 160°.

For each temperature of the heating medium, that is, for the range of six temperatures from 227° to 160°, a figure was adopted for the probable temperature

which the air in the flue would assume in zero weather. For example, with steam at 227°, three flue temperatures, 150°, 130° and 110° respectively, were employed in the examination, and in the case of water at 160°, two flue temperatures, 110° and 90°.

This is in a measure assuming that the engineer designs an indirect system in part on the basis of a definite flue temperature, knowing that with certain radiation assembled together with a certain proportion of open or free spaces for the passage of the air, the depth of the radiator in connection with the temperature of the steam or hot water will heat air admitted at zero to the accepted flue temperature.

In each case calculations were made to ascertain the flue temperature when the air outside was at 20°, at 40° and at 60°, and finally to ascertain the corresponding room temperatures. The results are shown in the accompanying set of charts. These show the relation between



INDIRECT HOT WATER RADIATION—WATER AT 200 DEGREES

outside temperature and inside temperature, three for direct steam radiation and three for indirect hot water radiators.

HOW TO USE THE CHARTS

The use of the charts will be something as follows: If it is assumed that a system has been designed to warm satisfactorily with steam at 2 pounds pressure with a flue temperature in zero weather of 120°, and the test is made when the temperature outdoors averages 25°, reference is made to the chart for the steam radiator working with steam at 2 pounds pressure. Running vertically on the line above 25 one will find a point about half way between the two lines marked 110° and 130°, and then reading horizontally will find that the temperature in the room should average between 86° and 87° if the apparatus can be trusted to work rightly in zero weather. If one had planned to employ a temperature of steam or hot water in the indirect radiator in zero weather different from any given in the charts, one could find the room temperature for a radiator temperature both above and below that in mind, choosing the value of the room temperature from the two values obtained.

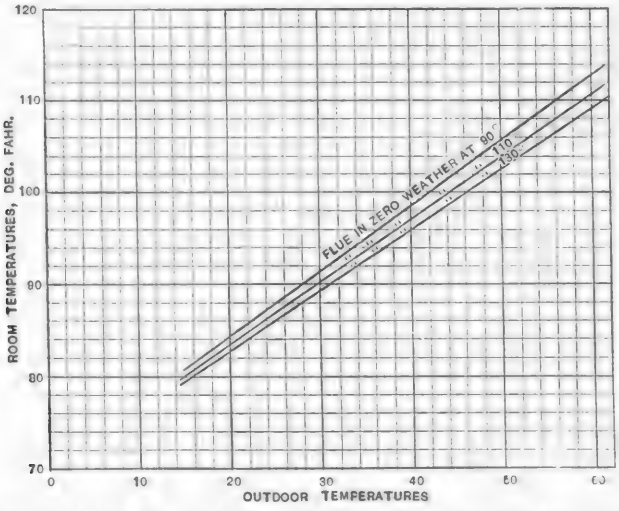
Take the case of a hot water radiator designed for water at say 205° and a flue temperature of 120° to be tested at 20°. For a hot water radiator at 200° and for 120° flue temperature, the room would be at 82.5°. Reference can then be made to the chart for the 212° steam radiator, when the room temperature will be found for the same zero weather condition to be 83.5°. The probable temperature is thus about 83°.

In this connection it must be noted that there is exhibited an apparent refinement of the temperature values. When the variation in methods of taking temperatures in the actual case is remembered as well as the variation in the records of the temperature, any necessity to interpolate in the manner explained seems rightly questionable.

The only inference is that a close approximation to the temperatures should be realized, as the values for any one basis of design are close to those for any other basis of design, and if the temperatures chartered cannot be reached in the test, there is question about its satisfactory capacity. This paper, of course, does not aspire to the scope of a code and no opinions regarding temperature measurement are vouchsafed.

In the foregoing it is assumed, as stated, that the system is designed on the basis of having the indirect radiator in zero weather at a certain temperature and obtaining the heated air at a certain

temperature. If such a practice is not followed, it can be assumed that the engineer knows from experience with other of his systems that with a definite steam pressure or water temperature the air is usually delivered at a certain temperature. Though he may lay out a system

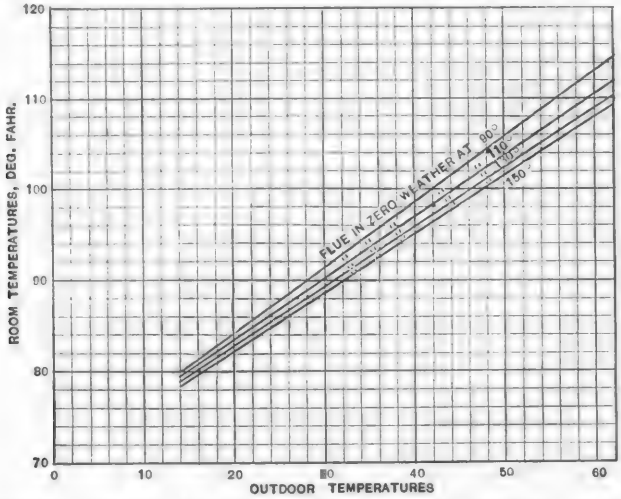


INDIRECT STEAM RADIATION—STEAM AT ATMOSPHERIC PRESSURE

without reference to the flue temperature a knowledge of its ordinary value assists in determining a proper test temperature.

ON THE DESIGN OF INDIRECT SYSTEMS

An interesting point brought out by the charts is the high room temperatures that result in moderate weather with apparatus designed to give low flue temperatures in zero weather. For example, as noted on the chart for the hot water radiator at 180°, higher room temperatures are indicated if the air is heated to 110° in zero weather than if it is heated to 130°. This means that when a system is designed to heat a specific building with 110° flue temperature as against one with 130° flue temperature a greater volume of air must be supplied in order to do the work, as the range of temperature that the air can be cooled to 70° in zero weather is less in the case of 110° than in the case of 130°. In other words, ventilation is secured in a greater ratio with a flue temperature at 110° than with the flue temperature at 130°, and greater ventilation means the escape of a greater amount of air, all of which has been heated from zero to 70°.



INDIRECT STEAM RADIATION—STEAM AT 2-POUND PRESSURE

This is repeating what has already been said, that a given indirect radiator that heats the air to 110° as against 130° is having the air passed over it at a higher rate of speed and is giving up a greater amount of heat per unit of sur-

face than when the temperature of 130° is obtained. While the increase in temperature is not so great, the volume of air is that much greater, so that the total amount of heat, as represented by the weight of air multiplied by the range of temperature, is greater than that with the less amount of air heated through the greater range of temperature.

DESIGNING INDIRECT HEATING SYSTEMS ON THE BASIS OF FLUE TEMPERATURES

This relates to a matter of indirect radiation that is perhaps altogether too little understood, and that is the desirability of designing such systems on the basis of flue temperatures. It is commonly assumed that because one flue goes to the third story and another goes to the first the velocity in the higher flue, being greater, will bring about a greater amount of heat transmission from the indirect radiator.

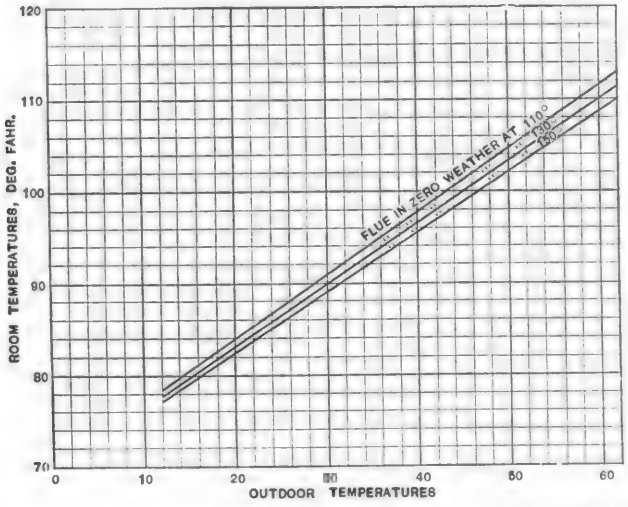
If the radiator, however, is of proper depth it will be able to raise the air in zero weather to, say, 150° without regard to the height of the flue. The amount of air to heat the given room when delivered into the room at 150° determines the amount of heat required, and therefore determines the size of the indirect radiator. Increasing the size of the radiator simply increases also in proportion the free area of cross section for the air passage so that the actual velocity of the air over the radiator is not increased, but is kept constant. The fact that the velocity is greater the higher the flue simply makes it possible to reduce the area of that flue according to the height of the flue and according to the amount of air that the flue must deliver.

RULE FOR FINDING THE TEMPERATURES

A rule instead of the charts can be used for finding the room temperatures and is as follows:

Multiply the outside temperature in degrees Fahrenheit by a factor given in the following list and add 70 to the product, when the sum will give the room temperature which should be reached by the system. The factors are given for different temperatures in the indirect radiator and for different temperatures in the flue on the zero weather basis:

	Factor.
For steam at 5 lb.:	
Flue in zero weather at 150 deg.	0.63
" " " 130 "	0.66
" " " 110 "	0.69
For steam at 2 lb.:	
Flue in zero weather at 150 deg.	0.63
" " " 130 "	0.65
" " " 110 "	0.68
" " " 90 "	0.72
For steam at atmospheric pressure:	
Flue in zero weather at 130 deg.	0.65
" " " 110 "	0.67
" " " 90 "	0.71



INDIRECT STEAM RADIATION—STEAM AT 5-POUND PRESSURE

	Factor.
For water at 200 degrees:	
Flue in zero weather at 130 deg.	0.61
" " " 110 "	0.66
" " " 90 "	0.70
For water at 180 degrees:	
Flue in zero weather at 130 deg.	0.58
" " " 110 "	0.61
" " " 90 "	0.66
For water at 160 degrees:	
Flue in zero weather at 110 deg.	0.56
" " " 90 "	0.62

For an example, suppose it is desired to know the temperature of the room if the system has been designed to operate in zero weather at a water temperature of 190° and under these conditions the flue temperature is found to average 125°. For water at 200°, the factors are 0.61 and 0.66 for 130° and 110° flue temperature respectively, so that for 125° flue

temperature the probable factor is about 0.62. For water at 180° the corresponding factors are 0.58 and 0.61, so that for 125° flue temperature the factor is about 0.59. For water at 190° the factor is the mean of 0.62 and 0.59, or about 0.605. If the outside temperature is 27° the inside temperature corresponding is $70 + 0.605 \times 27 = 86.3°$. The same result can be obtained quicker by use of the charts.

(The author incorporated in his paper the calculations by which the temperature values were determined.)

DISCUSSION

In commenting upon his paper Mr. Macon said the conclusions he had reached indicated that the proper room temperature which should obtain in any warm weather test of an indirect heating system was roughly equal to

$$70 + 0.65\,t,$$

where t represents the outside temperature, so that, for example, with 40° outside, the inside temperature should be $70 + 0.65 \times 40 = 96°$. The author also explained that the code for testing direct radiation plants, submitted to the society a few years ago, suggested the advisability of not making tests when the outside temperature was much above 40°.

The next paper on the programme was entitled "The Derivation of Our Constants for Building Losses," by R. C. Carpenter.

(This paper will appear in our March issue.)

DISCUSSION.

PROF. CARPENTER: In the publication of the paper I shall include the translation of that portion of Peclet's work which relates directly to the experiments in connection with the co-efficients from buildings.

What Peclet actually did in making these experiments was to take a small proportion of the different materials with which he made a series of experiments with different temperatures. He carried these experiments through, although he found that the co-efficient under average conditions varied with the temperature. As the temperatures approached each other the co-efficient became less.

It is a fact that heat transmission is more active per degree difference of temperature when the range is great than when the range is small.

MR LEWIS: That would indicate that Peclet's factors are sufficient with a range of 70° in zero weather.

TOPIC NO 3.

In the So-called Fan, or Force Blast System of Heating, How Should the Amount of Heating Surface in the Tempering and Heating Coils Be Determined in View of the Variation in Practice?

(No discussion.)

TOPIC NO 4.

Fuel Required to Operate a District Heating Plant and an Electric Plant Combined, Using Exhaust Steam for Heating, as Compared with a Heating Plant Alone Using Direct Steam.

(No discussion.)

TOPIC NO. 5.

The Air Space Required Through Hot Blast Heaters.

MR. BARRON: In regard to this topic the free area ought to equal the blast area.

PROF CARPENTER: This question is one regarding which the practice differs greatly. It is also a matter of considerable importance in connection with the efficiency obtained in the blower systems of heating. I do not think we can state the amount of space definitely; it depends upon the shape of the pipe, whether a round pipe, and also upon the depth or number of pipes through which the air passes. As this air becomes heated, it loses some of its power to take up additional heat.

I found in a series of tests, where we used sixteen rows of pipes, the air obtained three-quarters of its temperature in the first four rows. Probably, if we had had different spacing between the pipes, this result would have been different. I think it would be very desirable if it could be referred to our Committee on Standards to let them see what data they can get.

COMMITTEE ON COLLECTION OF DATA ON FAN BLAST HEATING.

On motion of Mr. Chew, it was voted to appoint a special committee of five members to collect data on fan blast heating to report to the Committee on Standards, and also to formulate and analyze the blower data in the proceedings of the society.

SPECIAL TOPICS.

1. *What Amount of Water Per One Hundred Feet of Radiation Should a Cast Iron Steam Boiler Hold to Give the Best Results? Is 6.5 Gallons Enough? If Not, Why Not?*

2. *What Should Be the Temperature in the Radiators of a Hot Water Apparatus When the Water Leaves the Boiler at 120°, 140°, 160° and 180°? Should it Be Less or More Than 10°?*

SECRETARY MACKAY: I presented a paper a number of years ago on the second topic, and after investigating a number of plants, my conclusion was that the average hot water apparatus will show a drop of nearer 20°.

Third Day, Morning Session

The first paper at this session was entitled "Comparison of Quick Circulating Systems of Hot Water Heating," by C. Guitton.

(This paper was read by Mr. B. H. Carpenter and is presented herewith.)

Comparison of Quick Circulating Systems of Hot-Water Heating*

By C. Guitton, St. Etienne, France

The system which was described by the inventor, A. B. Reck, at a meeting of the American Society of Heating and Ventilating Engineers (Transactions Vol. X., 1904), is the prototype of all systems in which the water in a closed circuit is mixed with steam (Brückner, Hamelle, Kœrting, etc.).

Its principal feature is the double action of the steam upon the ascending column of a thermo-siphon with closed tank. One of the ordinary features is to heat the lower part of the column. The other, a new feature, is that a certain amount of steam rises to the upper part of the pipe and is there mixed with water, forming an emulsion or mixture of low specific gravity.

For this purpose a steam generator is used in Reck's system, more complicated certainly than a water boiler, but also more efficacious by reason of its arrangements for regulating the fire and the pressure of steam. An apparatus, called a reheater, through which flow both the water from the boiler and the steam from the generator, raises the temperature of the main rising pipe, without causing it to boil. Another apparatus, called a circulator, probably from the fact that it is the chief factor in inducing circulation, is fixed at a certain height on the rising pipe; a certain amount of steam from the generator is allowed to penetrate into this apparatus and mixes in the form of steam bubbles with the water from the rising pipe.

All the systems derived from the above, such as Brückner's, Hamelle's, Kœrting's, etc., make use of a simple water boiler to obtain this double action, the body of the boiler forming the lower part of the ascending column, as in the case of an ordinary thermo-siphon. At a certain height on this column a steam space is arranged into which the steam from the heated water in the boilers gathers. In this steam space is an arrangement of varying shape, which serves to split up more or less the steam penetrating into the water, after the fashion of an injector. In these systems the boiler acts as reheater and the steam space as circulator. There are two particularities in this method of installation: the water heater becomes a boiler as it has to produce steam, and the injector, with its constant and even flow, has to discharge all the steam issuing from the boiler. It differs from Reck's system, in that the rising water boils before arriving at the mixing point, and because there is no fixed mixing proportion.

In all the systems, whether Reck's or derived therefrom, the current of hot water, which is saturated with steam as soon as the injector begins to operate, rises directly upwards to a closed expansion tank: the two fluids will there separate freely, the water, being heavier, will remain at the bottom of the tank and will descend through the hot-water main, while the steam rising to the top of the tank passes through a pipe to a condenser. The use of the condenser is twofold: first, it lowers the pressure of the steam which might otherwise set up counter pressure in the rising main, and, secondly, it returns the condensed steam to the boiler. The essential qualification of a regular circulation being its power of absorption, this must be kept in perfect order so as to ensure a regular condensation.

In Reck's system the condenser is cooled by the water from the rising column passing through it, at a point where the water is not yet boiling, say, below the mixer. In the derived systems the apparatus is cooled in different ways: Brückner—by spraying the steam into the return water; Hamelle—by means of a dome placed above the expansion tank and well exposed to the action of the air; Kœrting—by means of the cooling action of the water in the descending pipe. These different positions of the condenser in the systems derived from Reck's are necessitated by the water boilers which are used, and which, as stated before, superheat the water in the lowest part of the rising pipe.

In spite of these differences, all the circulations, Reck, Brückner, Hamelle, Kœrting, etc., are based on the same principle and have the same end in view.

If we omit their condensers, which are of secondary interest, they can all be represented concisely as in Fig. 1.

General Construction of Systems

A is the source of heat, a steam boiler having a reheater over it, or a water boiler;

B, the closed expansion and separation tank;

AB, the ascending column, heated at its lower part *A* and mixed with steam in its upper part *E*;

BC, the descending column or heat distributor;

BD, the special piping for reducing the steam pressure when it reaches *B*, and for returning the condensation to the boiler;

E, the mixing point, either with steam coming from outside the rising column

*Paper read at the Thirteenth Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

or from the space arranged on the column.

This sketch shows that the flow of the water, *ABC*, is accelerated in proportion to the difference of density in the columns *AB* and *BC*. It is clear that assuming the specific weight of the water to be 1, this difference will be at its maximum if these densities are 0 in the rising column *AB* and 1 in the distributing pipe *BC*.

But such a difference is impossible, whatever be the height of the part containing the mixture, *h*, on the column *AB*. To bring that about there would have to be no water at all in the ascending column, and only water at 4° C. (39° Fahr.) in the pipe feeding the heating surfaces. It would be impossible to get anywhere near such a difference. For, if the average density of the column *BC* can be kept very near to unity, to say

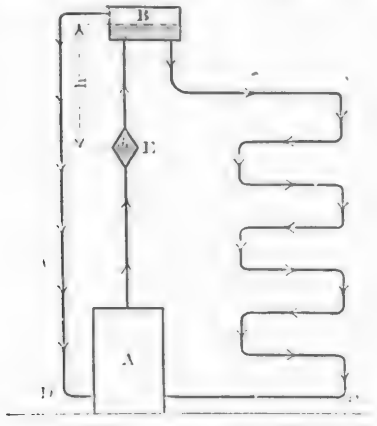


FIG. 1

0.98 for instance, the specific weight of the emulsion depends upon two factors, a minimum of water and a maximum of steam, both of which cannot be overstepped. The minimum is the water which should pass through the heating surfaces to ensure the desired emission of heat from them. The maximum is the steam which can positively be condensed by the water itself in the circuit.

This difference of density of the two columns is still further decreased by the rather low temperature at which it is proper to introduce the steam in the rising pipe, its lowest temperature depending upon the heat units which could be given off in the circuit without causing a local boiling. In effect, the result of this boiling would be a counter-pressure to the rising force of the emulsion.

An example will show clearly the importance of this condition: Let us suppose that the temperature of the steam gives an emulsion at 120° C. (248° Fahr.). If the pressure in the separating tank is very slightly in excess of the atmospheric pressure, each liter of the emulsion will give off therein 120 — 100 =20 calories (79.2 British thermal units). Let us suppose, on the other hand, that the water of the ascending or descending column, which acts upon the condenser, has a temperature of 85° C. (185° Fahr.).

A liter of this water can only absorb 100—85=16 calories (59.4 British thermal units); otherwise it would reach the boiling point. Now, the 15 calories absorbed only represent ¾ of the 20 calories to be reduced, and the difference unabsorbed would set up counter-pressure.

To avoid this excess, Mr. Reck sets a limit to the height of the separating tank above the circulator. For, the stronger the water pressure on the injector, the higher must the steam pressure be raised, that is, its temperature, in order to equalize this pressure. Otherwise the steam would not be able to penetrate into the pipe. According to Mr. Reck the proper height is that which limits the specific gravity of the part mixed to one-half of that of the descending column of the same height. This difference of one-half of the specific gravities would ensure a velocity in the circulation of 14 or 15 inches per second, in pipes of ¾ inch and ½ inch, such as are generally used.

From these data, as well as from the preceding considerations, we can conclude that there is a normal limit to this difference of specific gravities and that this limit, one-half, is the normal motive power in Reck's circulation.

It is not probable that other systems of mixed circulations would increase this particular force. If a water boiler forming an integral part of the circuit is substituted in place of a steam boiler acting parallel to the circuit, the pressure regulating devices would have to be placed considerably further off, thus causing their working to be more imperfect and less easily controlled. The safety valve is put on the highest point of the circuit, and the draft of the pressure regulator must be acted upon by the steam from the separating tank.

Further, as the injection can be no longer regulated, it depends on the tension of the steam accumulated in the ascending column, and which is often immoderately high. This pressure may become so great as to drive back the water from the boiler, even partially emptying the latter. This phenomenon, which happens accidentally in thermosiphons with open tanks, becomes in this case quite natural, because the water in the boiler is usually close to boiling point.

Finally, the fact of reducing the pressure of the circulating steam by reheating the descending column results in the decrease of the specific gravity of this column and of thus opposing a resistance to the upward (ascending force). For

these reasons it is believed that the difference of specific gravities, which usually takes place in the circulations derived from the system, should not be greater than that of the system itself.

We therefore give a résumé of the generic characters of all these circulations:

I. They are based upon the partial emulsion, by steam injection, of a closed water circulation, the pressure of which, constantly tending to increase, on account of the steam acting in a closed tank, must be regulated by safety devices such as are used for steam generators.

II. The motive power obtained under these conditions of emulsion and regulation may be represented by the difference between two columns of the respective value of 2 and 1, thus $2 - 1 = 1$.

ROUGUAUD'S CIRCULATION, OR CIRCULATION "BY FALL"

This system is very different from emulsioned circulations. Specific weight plays no part in it. It resembles steam heating "à air libre," in which the water of the distributor falls by its own weight into an open tank, before entering the boiler where it is to obtain a new supply of heat for a fresh effort. There is this difference, however, that the water rises not in steam but in the form of a boiling fluid.

This circulation comprises three phases: the flow of hot water in the distributor, the flow of the cooled water to the boiler which is provided with a special elevator or water lifter, and the raising of the boiling water to its highest point. These phases are shown in Fig. 2 by single, double and triple arrows.

A is the topmost reservoir, or overflow tank;

B, lower tank, or collector;

C, water boiler with elevator *c*, either inside or outside the boiler.

The distribution through the circuit is brought about by hot water, at 100° C. (212° Fahr.), falling freely from the upper reservoir, or open tank *A*, to the lower open tank *B*, in accordance with the natural laws governing bodies falling through space and the laws of gravity. The motive power is not caused by a difference in density but by a difference in levels, the height of the drop *h*.

The water is returned to the raiser through the boiler by another drop, from the lower tank *B* to the chamber of the elevator *c*, which communicates with the air by a large-sized pipe *cA*. The motive power of this flow is again a difference in levels, the height *h''*.

The rise of the boiling water, from *c* to *A*, is assured by means of an improved hydraulic valve, whose work it is to keep the steam tension in *c* equal to the static pressure of the column *cA*. This tension can never exceed this static pressure, for as soon as the tension simply equals the pressure of the column, the hydraulic valve causes the water in the pipe *cA* to flow out and then the steam space is placed in direct communication with the air. The motive force for this discharge is again a difference of levels, *i.e.*, the height *H* being the sum of *h* plus *h'*.

Consequently every part of the circulation is governed by a static pressure exclusively.

We see from these three phases that the current falling in a cascade from the upper tank, through the lower tank, to the elevator chamber, may be either constant or intermittent. Constant, if the quantity of the three discharges are equal for the same time unit. Intermittent, if one should not balance the two others.

It is less easy in practice than in theory to equalize these three discharges. Besides, as the object of the heating installation is to accumulate in the distributing circuit a certain quantity of calories per hour, it is not indispensable to have a continuous current. Therefore a regularly recurring current has been adopted.

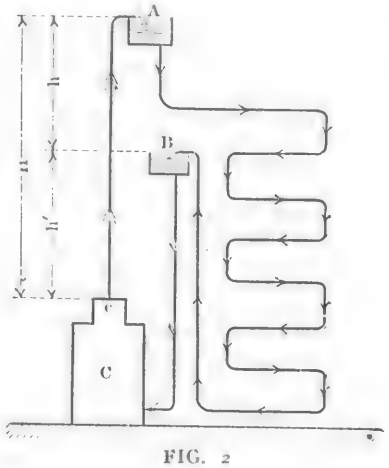


FIG. 2

In order to ensure this regular recurrence, we must calculate what discharge must be furnished by the elevator per hour, and arrange for its intermittence in such a way that the greatest frequency in the elevations shall correspond with a maximum of cold.

The practical rule given for attaining this maximum is easy to observe and has been sanctioned by five years' experience in heating work. It gives a time limit of 60 seconds for the fall of a certain quantity of hot water through the circuit, and a slightly shorter time limit, say 50 seconds, for an equal quantity of cooled water to pass from the lower tank to the upper tank, with the aid of the elevator. The margin of 10 seconds between these two flows simultaneous represents the minimum interval between the falls at their greatest frequency, or an instant of rest.

This instant makes the dividing line between the two flows forming the parallel transport, that is, the filling up of the elevator through the boiler and the ascension of the boiling water, the time generally taken for these two flows being respectively 20 and 30 seconds, or a total of 50 seconds.

This rule establishes the proportion of the heights h and h' to the height H for given diameters of piping and, consequently, the velocity of the three currents. These velocities are generally 0.50 to 0.70 meters (20 to 27½ inches) per second for the fall in the distributing mains, and from 1 to 1.40 meters (40 to 55 inches) for the fall into the elevating chamber. These two velocities are independent of each other, and they are also each independent of the velocity of ascension, which is usually limited to 0.5 meters (20 inches). On account of these velocities being independent, it is possible to take very small diameters for the distributing piping, such as ¾" (20 mm.), ½" (15 mm.) and even less, and to place the piping of larger diameter near or above the boiler.

It should be remembered that there is an instant of rest allowed for between two series of flows. The interval of rest at the point of greatest frequency of these series is 10 seconds between the two falls in the distributing piping and 40 seconds between two falls in the elevator.

The velocities per second of the two falls cannot, therefore, correspond to the velocities per hour, as is the case with the continuous currents. The amounts they discharge per hour are, in fact, identical with what would be obtained with lower continuous velocities of $\frac{10\times60}{3600} = \frac{1}{6}$ for the first flow, and $\frac{40\times60}{3600} = \frac{2}{3}$ for the second. They must therefore be returned to their effective value per hour by subtracting respectively 1-6 part and 2-3.—If we take their averages, $\frac{0.50 + 0.70}{2} = 0.60$m (23.6 inches) and $\frac{1 + 1.40\text{m}}{2} = 1.20$m (47 inches), and make the reductions, the mean practical velocities are still 0.50m $\left(\frac{0.6 \times 5}{6}\right)$ for the first fall and 0.40 m $\left(\frac{1.20 \times 1}{3}\right)$ for the other one.

In this study of the circulation there is no necessity to go into details as to the use of the steam given off by the water supplied by the elevator, at a temperature in proportion to the height H. Even if it were of no utility it would have no influence on the circulation. It is enough to point out that this steam is, as in every well-devised installation, undergoing total recuperation, both as regards latent heat and water of condensation. It is taken up again by various apparatus for the benefit of the circulation or its exterior service, according to the rules regulating its escape to the open air and without inducing counter-pressure.

The natural limit of the periodic circulation properly arranged is continuous circulation. It becomes continuous as soon as the heating power of the boiler is greater than the requirements of the circuit, whether maximum or temporary. This creates no difficulties. But it is not used on account of its action being less powerful and less efficient. Consequently, the transmission of heat from the boiler is limited by means of a double fuel regulation, one being regular, the other optional. The former is fixed once for all to suit the maximum of cold to be overcome. The latter varies according to the season or to suit individual requirements.

Should the heating power thus determined be excessive, the return flow of water, generally assumed to be at a temperature of 70° to 80° C. (158° to 176° Fahr.), will arrive in the boiler too hot, and will partly vaporize there before reaching the elevator, thus causing an excess of steam pressure in the box of the hydraulic valve. The consequence of this excess would be to modify the working of this apparatus and make it act as an injector.

The ascending water becomes saturated with steam, as in the mixed circulations, and rises continuously. Then its current is maintained by means of a steam tension which balances the static pressure h' of the lower tank above the elevator chamber.

However great may be this static pressure, the steam cannot take up more room than the capacity of the hydraulic valve-box, because the precise characteristic of this device is to set up direct communication between the steam and the outside air as soon as it attains this volume. Consequently the steam can never expand in the water boiler, as often happens with thermo-siphon.

As soon as the heating power of the boiler is again brought down to the requirements of the circulation, either from the fire having been moderated on purpose or naturally, or by the cooling of the return water, the water returning to the boiler no longer gives off steam, the excess of steam disappears in the elevator chamber, and continuous circulation again gives way to periodic circulation.

Both in the continuous and periodic circulation the motive force of the circulation is a pressure solely static.

The leading features of this system may be thus résuméd:

1. It is based upon the periodic or continuous fall of water from open tank into

open tank, through open circuit, and the pressure being solely static, there is no need for the use of any safety device.

II. The motive force of the circulation in the heating circuit may be represented by the difference between two columns of the respective values of 2 and 0, thus $2 - 0 = 2$.

DISCUSSION

PROF. CARPENTER: In regard to the possibility of getting quick circulation in hot water systems, our attention was first called to that in a paper by Mr. Reck, presented at an earlier time before this society.

I want to call your attention to the fact, however, that systems of quick hot water circulation have been used in this country to a considerable extent in car warming for a number of years. The Baker system of car heating, for instance, was patented in 1861 and has for years been used extensively.

You will find in the use of the Baker heater that in order to get circulation, the water must be hot enough to make steam in the upper part. The steam bubbles lift the water in the riser up to the expansion tank and the water then falls by gravity, passing down through the various pipes and entering the heater. The water is driven by the action of the steam in every instance to the top of the system and then falls by gravity. That is the same as the system described in this paper, although Mr. Guitton has traps or hydraulic valves, as he calls them, by which he assists the circulation.

The expansion tank in the Baker system has to be provided with a safety valve. The system would work all right without the safety valve and the same results would be obtained as Mr. Guitton says he has obtained with his system in which he leaves the expansion tank open.

The advantages, it seems to me, of such as a system, if they are any, are due to providing more rapid circulation of the water than to the advantages which are claimed in this paper. The circulation system of Guitton is perhaps more effective than the Baker system.

MR. BARRON: I want Professor Carpenter to say a few words about the origin of the Baker system and its comparison with the Perkins system.

PROFESSOR CARPENTER: In operation they differ greatly. In the Baker system the circulation is dependent upon the steam bubbles, whereas in the Perkins system there is not this feature. In the Perkins system the water is under high pressure and the temperature can be high without producing steam; having a high temperature in our pipes we can therefore use small radiators. I do not know whether Baker knew, when he took out his patent for his system in 1861, that his circulation was obtained through the action of the steam boilers. He made no mention of it.

The next paper was entitled, "Systems of Heating Railway Cars with Hot Water," by R. C. Carpenter.

(Professor Carpenter's paper, which included a description of the Baker system of hot water heating, will be presented in our March number.)

Electric Heating and Steam Heating

(In connection with the discussion of Professor Carpenter's paper on systems of car warming, the general subject of electric heating, as compared with steam heating, was taken up and may be presented under the above heading.)

DISCUSSION

MR. BARRON: It strikes me the heating of cars can be done electrically within a short time and that ventilation will be done the same way. By the use of small fans operated by electric motors. Electric traction is already started, and we know that is an accomplished fact. Electric heating and ventilation will follow it.

MR. BALDWIN: I should like to give some facts relating to the cost of electric heating as compared with steam heating. I believe it is allowed that it costs more to heat a car than it does to haul it.

Some years ago I had occasion to determine the relative value of electric heaters. I took a steam radiator containing 28 square feet to make the comparison and a summary of the whole thing is this: the 28 square feet amounted to a condensation of about 7 pounds of water in an hour or ¼ of a horsepower, while the electrical instrument showed that in the same time the electric heater doing the same work was using 3 electric horsepower.

SECRETARY MACKAY: I understand that the Public Service Corporation of New Jersey, which heated its cars with electricity, has lately replaced these heaters with small hot-water heaters, the water being heated by electric current.

MR. JELLETT: Reference has been made to heating trolley cars. Professor Carpenter's paper refers to railway trains. They are different propositions. The trolley cars are open at every block and constantly chilled by the opening of the doors. In the heating of railroad trains the doors are usually opened only at the stations. Proper heating, therefore, of railroad trains by electricity is not as difficult as the heating of trolley cars.

There are a number of engineers experimenting at the present time in connection with heating electrically. Our company heated a residence here in New York by that means some time ago for a man who wanted an electric heating system. We had great difficulty in keeping a finish on the radiators. We had to put

shields around them, made of polished brass and lined with asbestos. We first used white enamel, but it peeled off. We tried two or three other methods and finally got a kind of lacquer that seemed to stand very well. We had difficulty to get anything in the way of varnish, paint or bronze to retain its color any length of time. Dull, dead black seems to be better than anything else. The proportionate cost of electric heating vs. steam heating is about 4 to 1. Electric apparatus however, requires no man to attend to it and I doubt, counting the labor and fuel, whether the ratio in a residence where an attendent is employed would be more than 2 to 1 against electric heat.

Using this as a basis of argument, I see no reason whatever why railway trains making long-distance runs should not be heated in some such way, although I believe that if they put the electric energy into some satisfactory method of heating water they will get the results desired, and at less cost.

MR. FRANKLIN: Please state the approximate cost of the electrical installation as compared with hot-water installation.

MR. JELLETT: In that particular case the bid for hot water was $1,860. The cost of the electric heating apparatus was $1,500.

TOPIC NO. 6

The Relative Healthfulness of Direct and Indirect Heating Systems.

MR. CHEW: The original question from which this topic was derived was as follows: Is hot-air furnace heat more healthful than direct steam or hot-water heat?

MR. SCHAFFER: The trouble in furnace heating is due to poor work. Especially do we find the overheated furnace in sections where they use natural gas. They call it a furnace, but it is nothing more than a galvanized funnel with a register on top, and the gas flame going up through the center draws the air from the cellar, or where it can get it, up through that tube and through the register into the house. That certainly, in my opinion, is rank poison.

MR. BALDWIN: A danger that always exists in a furnace is that of gas leakage. Let any man who has a furnace in his house hang his silver watch on the face of the register and see how quickly it will turn black. That is an indication of sulphur. It shows that one element of combustion is coming into the room and perhaps all the elements of combustion are present.

Reference has been made to air entering a schoolroom at 110°. That is proof positive that you are not getting enough air for proper ventilation in that room. The quantity of air necessary for school ventilation which enters a room at 110° will carry more heat than the windows and walls can cool under the most extreme conditions. So when one enters a schoolroom, and finds the air is coming in at such a high temperature, he can make up his mind that there is some doubt about the ventilation. It is one of the rough methods of judging the ventilation, in fact. Probably 85° or 80° is as hot as 100,000 cubic feet of air can enter a schoolroom in an hour, if overheating is to be avoided in our latitudes or where the average outside winter weather is between 20° and 40° F.

The heat above 70° F. in 100,000 cubic feet of air, admitted at the register at 85° F., is approximately 30,000 B. T. U.; equal to the condensation in 120 square feet of good ordinary radiators.

A rough rule to bear in mind for the school teacher or engineer would be, that for each 2° to 2½° the ouside atmosphere is below 70°, the air as it passes the register should be 1° above 70°, so that air at 110° F., as it passes the register, provided it came in school quantities, would keep an ordinary schoolroom warm within the arctic circle.

TOPIC NO. 7

The Variation of the Boiling Point Under the Same Degree of Vacuum at Different Altitudes.

PROFESSOR CARPENTER: There are a number of tables in pretty nearly every handbook that will give exactly what is asked for in that question.

TOPIC NO. 8

Rated Surface of Radiators versus Actual Surface.

MR. WOLFE: I believe if the radiation were guaranteed the engineer would save considerable trouble, because he could then say there are so many square feet of radiation guaranteed.

SECRETARY MACKAY: I have found that it is not so much a lack of surface or shortening of surface as it has been a lack of air space in the ordinary type of two-, three- and four-column radiators.

MR. BRADY: I know of an instance where an unsatisfactory heating system was due to the fact that the architect's specifications called for three coats of white enamel to be put upon the radiators, which is about the same as asbestos. To settle the question, I decided that in certain rooms they get radiators of the same sizes as the one then in place and turn on the same amount of steam under the same conditions. They had no further trouble at all.

MR. BALDWIN: Sometimes when we have set a radiator up perpendicularly, the room will not get warm, but when we set it at an angle of 90° or 45° the room gets warmer. Turn it on its side and the air will pass through it in a different way altogether. The thing, therefore, to consider in selecting direct radiators for efficiency only is the case with

which the air comes in contact with them and passes through them.

In the case of a seminary in which the vertical single column radiators proved deficient during the cold snap of the first winter, the speaker had the radiators pulled forward at their upper ends and rested on boxes temporarily. The effect on the warmth of the rooms was quickly apparent. Wall or stateroom radiators should be set with the base vertical. When the bars are horizontal, they will not do so much work.

Like work per unit of surface of radiator is practically impossible, unless, indeed, we decide to adopt a single style of radiator, which, of course, business interests and beauty of design will never tolerate.

MR. THOMSON: In a plant which I laid out, about a year and a half ago, I decided to measure up the radiators after they had arrived on the job. I found the indirects 18% short. Some of the standpipe radiators were pretty nearly the same and other sizes, not regular sizes, were a little short, some 80% or 10%.

MR. BARRON: I want to ask Mr. Wolfe if he does not think that radiators on an average are rated about 20% above their actual radiating surface?

MR. WOLFE: Yes, I think so. I think they are made according to a certain diameter.

SECRETARY MACKAY: My experience is that many of them are anywhere from 5% to 10% short of surface and that some of the four-column radiators would be 20% less in efficiency than a two-column or three-column, due to the inner tubes radiating against the outer ones. I do not believe I ever had a radiator more than 10% short.

We should not only investigate the measurements but the condensing power. That would be a matter for the Committee on Tests as well as the Committee on Standards.

Third Day, Afternoon Session

This session opened with a reading of a paper on the "Relation of the Force of Gravity to Some of the Economics of Heating," by Dr. J. M. W. Kitchen.

*The Relation of the Force of Gravity to Some of the Economics of Heating**

BY DR. J. M. W. KITCHEN

Dr. J. M. W. Kitchen

SOME twenty years ago I devised a pneumatic chimney check draft, with a view of preventing the escape of coal gas into my cellar from my household heater after the introduction of fresh charges of coal. This replaced the old check draft that is largely in use today, and which was located in the side of the smoke pipe, and, if not closed, shows coal gas to escape through it whenever a large amount of gas is evolved from the fuel. I replaced this defective appliance by a simple dependent conduit of the calibre of the smoke pipe, connected with a T in the smoke pipe, the dependent conduit being controlled by an ordinary obstructive damper. It was open to the atmosphere at the bottom at a level near to the floor line. The column of cold air contained in the conduit prevented the hot gas from traveling downward in it more than three or four feet. Hence, with this simple device, I have always been able to control the chimney draft to any degree, without being annoyed or injured by escaping coal gas. I have used the same principle in several practical applications with advantage, thus utilizing the force of gravity.

RELATION OF FORCE OF GRAVITY TO ACTION OF DRAFT IN HEATING APPARATUS

Every person of any intelligence knows that the force of gravity is in some way related to the action of draft in our stoves and heating appliances; yet if we are to judge from the work of inventors and manufacturers in the allied arts of heating and power production, there must be very few who have a comprehensive appreciation of the extended nature of the action of this force.

In considering the practical application of this particular branch of knowledge, we must not forget that this force is acting everywhere and in every form of matter. Its activity is particularly observable in connection with water and other fluids, and in air and other gases. It is active in vacuums of greater or lesser degrees, and in cavities and passages that may contain gases or water, whether these passages or cavities are open to the atmosphere or not. This force acts upwardly in the cases where a lessening of the line of resistance has been accomplished. For example, a fire is lighted in a vertically placed tube and expands the gases in the tube. The result is a line of lessened resistance in that tube and air of a cooler temperature is forced into that tube from below.

*From a paper read at the Thirteenth Annual Meeting of The American Society of Heating and Ventilating Engineers, New York, January 22-24, 1907.

Furthermore, it is apparent that air will be forced into that tube through any opening under atmospheric weight from any direction, following the lessened line of resistance. If one partly closes the controlling draft apertures of a heating stove, and special avenues for the entrance of air above the fuel mass be provided, and by deflection the travel of a column of cold air be initiated towards the zone of combustion in the heater, you can secure the contact of a very considerable amount of air for combustion with the fuel mass, and thus keep up quite an active rate of combustion. In some types of heaters you can thus introduce air for combustion by deflecting a cool current of air within the smoke pipe of the heater from a great distance, and keep up a brisk rate of combustion with a comparatively small amount of air being introduced through the fuel mass from below the grate line. This fact can be scientifically demonstrated at any time, and is due to what may be called the inductive or injective force of gravity.

AIR FOR COMBUSTION SHOULD BE INTRODUCED ABOVE FUEL MASS

As a principle it is worthy of consideration, because in the future it will be recognized that to secure the utmost economy in heating, a very large amount of air for combustion should be introduced above the fuel mass in divided currents around the periphery of the lower part of the combustion chamber. This will apply even to those cases in which careful and continuous stoking is done by either hand or by a mechanical stoker; and where the preservation is maintained of an equable surface of a thin bed of fuel.

In our ordinary household heaters the recognition of the principle is of great importance. In such cases the requirement of convenience in attending to the heater and infrequent replenishment of the fuel mass must be consdered; and in which cases a thick fuel mass must be maintained unless the alternative disadvantage of air dilution is experienced. In such cases, while there are sufficient air spaces between the particles of fuel an approximately sufficient air supply for combustion passes through the fuel mass under atmospheric pressure, the particles of fuel not being greatly changed in their shape; but very soon the air interstices become clogged with ashes, and the upper lavers of fuel are then simply baked, much gas being given off and escaping without having become combined with sufficient oxygen to secure complete chemical union.

Furthermore, a large over-fire air supply conduces to an equalization of the rate of combustion. It conduces to a more moderate rate of combustion immediately after the fuel has been fed, and secures more heat from the volatilized gases later on. In taking cognizance of these facts a reduction of from twenty-five to forty per cent. in the cost of fuel and heating can be secured in household practice. The greatest part of this saving is due to not burning fuel when its burning is not needed, as in the early part of the night in dwellings and greenhouses.

LARGER GRATE AREA AND HEAT-ABSORBING SURFACE NECESSARY

Note should be made of the correlative fact that the overfire air feed results in a so much slower rate of combustion that, to make good this left in heating, a larger grate area and more heat-absorbing surface must be provided to secure sufficient heat generation; but this extra initial expense in the installation will be made good at the rate of one hundred per cent, returns in every year's work through the saving of fuel.

Another fact to be considered more closely than has been done is, that under the law of gravity, heated gases rise vertically and are pressed upwardly against surfaces interposed in their path of travel. Now you will remember that a certain critical degree of heat is necessary to secure complete combustion of gases and air, and that time is required to secure mechanical admixture of air and gases, while the travel of heated gases through the passages of the heater is quite rapid. You will also remember that a good heat absorbent, if brought in contact with hot gases, will absorb heat very rapidly and in great quantities. These facts seem to have been partially ignored at least in the designing of nearly all heating and power producing boilers in general use.

In these so-called practical designs heat is absorbed prematurely from the combining gases, and there seems but little question that in ordinary work, through the lessening of the temperature of the gases before combustion has become perfect, a large economic loss is sustained. This is specially so in boilers of the locomotive type, in which the gases are distributed through small tubes. I am told that flame is almost immediately extinguished in such tubes, and until flame disappears under advantageous circumstances no perfect combustion has been secured.

Gases that are conveyed through horizontal routes of travel through larger tubes or conduits, such as must be provided in the relatively rust-proof cast-iron apparatus of our household cellars, are conveyed in currents of large calibre, so to speak, and the hot gases in the interior of such currents do not have time, through the law of diffusion or through gravity, to be brought in contact with the heat-absorbing surfaces in the short space of time taken in their travel through ordinary heaters, this being es-

pecially so when the draft is entirely an updraft.

To secure a complete absorption of the heat generated in horizontal travel, a very long route of travel must be provided. This necessitates an undesirable great expense in structure; and, of course, if heat is withdrawn from the gases before combustion has been effected, there are losses in the chimney gases due to imperfect combustion as well as also due to lack of transmission of the heat generated.

There is an admission on the part of prominent manufacturers of a certain type of boiler that they secure the best economical results with a chimney temperature of waste gases of 400 degrees Fahrenheit, while, as a matter of fact, with a different arrangement of the heating surfaces and under ordinary atmospheric conditions in cold weather, two-thirds of this heat can be conserved; for there is needed to secure natural draft even with a difficult plunging draft only a difference of about forty or fifty degrees between atmospheric temperature and the temperature of the chimney gases in the chimney flue.

As a result of my experiments I do not think it is possible in ordinary household heaters to provide a sufficiently high run to the combustion chamber, owing to the limits of height in cellars, to secure an absolutely perfect combustion of the hydrogen gases under the natural force of gravity. This does not apply in burning the fixed carbon. In an ideal power plant, where mechanical draft can be employed, and in connection with intense rates of combustion, combustion chambers having a run of at least twenty feet in height must be provided to secure perfect combustion before heat is abstracted in its transmission.

ADVANTAGE OF HORIZONTAL HEATING SURFACES

A further fact of great importance to be considered is that when hot gases are confined they spread out horizontally in, what we may call for convenience, strata of equal densities at equal levels, if of like temperatures, the hottest gases finding lodgment at the top of the confined space, and the coolest gases at the bottom; and that if the column of gases thus confined is hot enough and high enough a very intense rate of heat transmission through the heat-absorbing surfaces occurs at the highest level. Advantage can be taken of this fact to secure economy in the initial costs of heating installations because of the lesser amount of metal needed to secure the sought-for end; in other words, that heating surfaces arranged vertically with great elongation will transmit a very much larger amount of heat to the square foot of heating area than if those surfaces are arranged horizontally.

CONSTRUCTION OF WATER BOILERS

It should be remembered also that the water in a boiler is under the influence of this same law of gravity which is always tending to secure the same stratification, so to speak, of the hottest water at the highest level, and the coldest water at the lowest level. When we consider this fact it is rather astonishing that boilermakers more or less entirely ignore the fact, because in the way in which they apply the travel of the heating gases in opposition to the water travel, they fail to provide in their apparatuses a water recipient of a sufficiently low temperature for large volumes of the low degrees of heat in the gases, and which are almost universally lost in the chimney gases.

Two or three hundred degrees of heat escaping in the chimney gases means a loss of at least ten to fifteen per cent. in the cost of fuel. Because of the neglect of applying the principle in its purity of first applying the hottest gases at the highest level of the absorbing surfaces, and then drawing them downwardly, with a final exit at the lowest level, and of introducing feed water of a low temperature at the lowest level, and conveying it vertically upward to a higher level, and thus procuring its progressive heating, the aggregate fuel wastes of the world is enormous every day.

NECESSITY FOR INDUCED AND FORCED DRAFTS

The last point to which I shall call your attention is that there is a limit to the power of gravity in controlling combustion processes and heat transmission. To secure a controllable draft and to secure the most economic results through a sufficient vertical elongation of the combustion chamber and heating cavity, a mechanically induced draft must be used; and to secure the most perfect combustion and the use of the cheapest fuel, a separately produced forced draft must also be used.

To successfully use the low-cost anthracite coal dust it has to be blown into the combustion chamber over a bed of burning fuel to catch the larger fragments and to produce the heat necessary for its regular consumption. A protective film of relatively cool air has also to be interposed between the intense heat generated by the burning dust in the atmosphere of the combustion chamber and the walls of the structure surrounding the chamber to prevent their destruction. Furthermore, a separate draft must be forced through the bed of fuel at the bottom of the combustion chamber, and wafting currents of air for intermingling the air with the volatilized gases must be provided. These several provisions require a somewhat complex means and their co-action is utterly beyond the direction of man through utilizing the force of gravity only.

In large power and heating plants there is need to vary from time to time the rate of combustion to meet the various requirements of the work to be accomplished, and to carry gases over areas of heating surfaces so large that all the heat generated shall be absorbed. A natural draft is not able to accomplish this.

In actual practice there is a large amount of loss due to air dilution in the combustion process and in heat transmission that is unavoidable when working with only the force of natural draft; but in the wider ranges of practice, especially in household heating, it is necessary to submit to this limiting defect of the natural force of gravity.

We have to remember that in charge of most household heating appliances is a person of very limited intelligence, who would not be capable of managing means for securing the greatest economy in the use of fuel, or for utilizing the cheaper kinds of fuel. But with proper attention to the design of heating structures a very great advance in the economies of heating can be effected; and there really seems to be no need of the very great heat wastes in heating and power production that are usual.

A proper consideration of these facts is of world-wide importance inasmuch as their practical application means that utilization can be made of the enormously large soft coal deposits on the earth's surface in power production, and in the production of a very cheap fuel gas for urban consumption, thus relieving smoke ridden cities and towns of the smoke nuisance, and of the inconvenience of the direct use of soft coal.

It also means that the valuable hard coal deposits can be conserved and carried along for a very much longer space of time for the various uses to which such fuel seems to be a necessity. It further means that a complete utilization can be made of the enormous accumulations of anthracite dust, and of coal dust that will in future be produced.

The several points herein touched can be elaborated and exemplified in the discussion which is invited.

Installation of Officers

Following the reading of Dr. Kitchen's paper, the President appointed Stewart A. Jellett and Hugh J. Barron a committee of two to escort the newly elected officers to the platform. The retiring President then greeted his successor, C. B. J. Snyder, and the other officers, and thereupon handed over his gavel to the new President.

On assuming the chair, Mr. Snyder said:

"Gentlemen, I pledge to you the high standing which this society has gained under previous Presidents and its various officers."

President Snyder then announced the appointment of a committe on fan and blower data, which was provided for at an earlier session.

Committee to Collect Data on Fan Blast Heating

William G. Snow, Chairman; R. C. Carpenter, J. H. Kinealy, F. A. Still and J. H. Brady.

President Snyder also announced the continuation of all committees, both regular and special, until further notice.

Topic No 9

Durability of Steel and Wrought Iron Pipes Used as Returns for Exhaust Steam Heating, Also When High Pressure Steam Free from Oil Is Used.

(No discussion.)

Topic No. 10

Expansion of Pipes Due to Heat from Steam, High Pressure 100 *Pounds and Upwards and* 10 *Pounds and Under.*

(No discussion.)

At this point the regular order was suspended while Secretary Mackay read invitations for the holding of the next semi-annual (mid-summer meeting) received from Milwaukee, Niagara Falls, Buffalo, Jamestown and Atlantic City. Mr. Brady spoke for Kansas City. Mr. Bennett, of the Bureau of Publicity of Niagara Falls, was given the floor and extended an invitation to the society to meet at that point.

Through a *viva voce* vote, a preference was expressed for Milwaukee.

Topic No. 11

Advantages for Standard Dimensions of Radiator Valves and Connections.

Mr. Jellett: This is purely a commercial question and, therefore, does not interest this society. A committee representing the National Association of Master Steam and Hot Water Fitters is now at work on this subject.

Mr. Donnelly: Committees from the American Society of Mechanical Engineers and from the Master Steam Fitters considered it a proper engineering question to establish dimensions of flanges.

Mr. Barron: It would not be a bad plan for us to work with the Master Steam Fitters, if they have any such thing under way, bearing on the topic under discussion. If the engineer could specify a certain 1¼-inch standard valve of such and such a make it would simplify work and is in the direction of progress.

Mr Chew: I move the Committee on Standards be requested to confer with the committee of the Master Steam Fitters' Association on this subject and lend such assistance as they can.

(This motion was carried.)

TOPIC No. 12

Should the Guarantee of Efficiency be Assumed by the Heating Engineer Who Designs the Apparatus, or the Heating Contractor Who Installs It?

MR. JELLETT: It has been stated that the consulting engineer should guarantee results. Not always. I know of a case where the architectural plans call for a building, 280x85, double sash. Afterwards the construction was changed by putting in swinging windows, swinging out, and they worked these windows with a series of chains. I visited the building recently to make an examination, the outdoor temperature being 10°. I found 80 per cent. of the windows were open three-quarters of an inch to an inch, and they could not close them.

There are a number of legal decisions on the point of the liability of the contractor. I know of cases where the courts have ruled that the contractor cannot be required to guarantee results to be obtained from plans and specifications furnished him.

PRESIDENT SNYDER: The point made by Mr. Jellett has been carried to the courts in every State in the Union, the most famous decision being in reference to a boat-house here in New York. One of the provisions was that it was to be built in a particular manner and guaranteed. The contractor was to erect the building according to specifications, and he did so. The court held that he should not be required to build according to specifications and to guarantee also.

MR. FRANKLIN: I would like to make the following motion: That it is the sense of this society that a guarantee of efficiency should be assumed by the consulting engineer who designs the apparatus.

(This motion was amended to read that "it is the sense of this meeting that the matter in question be referred to the Board of Governors, with a strong recommendation that they present it to the members of the society with proper blanks for a mail vote, so that the votes can be received in time for an expression of opinion at the next annual meeting." It was further suggested that copies of the discussion be made to be sent to the members with the blank vote.)

NATIONAL FIRE PROTECTIVE ASSOCIATION

On motion of Mr. Donnelly, it was voted that the Secretary and Board of Governors confer with the American Institute of Architects and with the American Society of Mechanical Engineers, and if possible learn from them the work that is being carried on by the National Fire Protective Association, and give the society such information, with a view to considering the advisability of the society's joining the Fire Protective Association as a body. On this point Mr. Donnelly said:

"The contractor very often has disputes with the Board of Fire Underwriters in regard to protecting steam pipes. It seems to me there is a good deal of dissatisfaction in the heating trade in regard to the requirements of the Board of Fire Underwriters."

The meeting then adjourned *sine die*.

Heating Engineers' Dinner

The annual dinner of the Heating and Ventilating Engineers' Society was held at the New Grand Hotel, New York, Wednesday evening, January 22. As was anticipated, the presence of the ladies lent a charm to the affair that will no doubt ensure their presence upon similar occasions in the future.

President C. B. J. Snyder acted as toastmaster and, after justice had been done to a well-arranged menu, the post-prandial speaking was introduced with a toast to the retiring president, John Gormly.

In introducing the first speaker, the toastmaster said:

"Looking backwards in the history of our society, there was a time when we were in need of sympathy and aid from a sister society. There we found one to whom we could turn with the assurance that we would obtain help, advice and encouragement. As secretary of the Society of Mechanical Engineers, this man did much to assist us in perfecting our organization, and now, as president of that society, I introduce to you Prof. F. R. Hutton."

Professor Hutton said, in part: "There is no lack of contact with heating and ventilating engineers in the Society of Mechanical Engineers. The mechanical engineers are thoroughly appreciative of the way you do things, of how, when you strike obstacles, you elbow your way around them, or if you find yourself in a coil of manifolds, you bow yourself out with a return bend.

"Speaking generally, your science has been thoroughly worked out. There are no gloomy things for you to ponder in the power field. You are not troubled with such matters as free expansion in the nozzles of gas engines. Your field calls less for creative solution but rather for creative application of old methods.

"You have also your problem regarding the presentation of papers of patented inventions. While it seems to me this matter should be treated broadly, there is always the danger, however, that a society may become a commercial exchange and that membership may be considered a charge against the advertising part of one's business.

"The heating and ventilating engineer has to conceal his work from the public eye, so that the world knows little of his accomplishments as compared with the man who builds bridges or automobiles. In the gathering of the engineering societies into one building as has now been

done, we emphasize the fact that engineers are great factors of the civilization around us."

Responding to the toast, the Chicago chapter, James Mackay said, in part:

"My subject is a large one. Our chapter came by reason of a need felt by a number of us in the Far West. As the previous speaker has suggested, we elbowed our ways around difficulties. Our chapter is now an accomplished fact and I believe its organization will have a helpful influence upon the entire society. I think in our course thus far we have dispelled all doubt as to the advantages to be derived."

Mr. C. V. Kellogg responded to the toast, "The Ladies."

Secretary William M. Mackay arose to speak upon "Our Treasures." During the course of his remarks he turned to former president, Alfred E. Kenrick, and in well-chosen words presented him, on behalf of the society, with a handsome silver loving cup in token of Mr. Kenrick's services at an earlier period in preventing a balance on the wrong side of the society's ledger at the close of the year. The inscription engraved on the loving cup is as follows:

"Alfred E. Kenrick, in appreciation of a service rendered to the American Society of Heating and Ventilating Engineers, New York, January 23rd, 1907."

Mr. Kenrick accepted the gift with expressions of his deep appreciation.

Speaking upon "Our Field," Prof. R. C. Carpenter said, in part:

"Less than a generation ago no engineer would admit a field of engineering along our line. He took the regular course of civil engineering, but later there came another field, mechanical engineering, relating to machinery and prime movers. This in turn was followed by electrical engineering, and so have come the numerous fields of specialization. Our field is not a broad one, but it is deep. The society has done a great deal, but there is much yet to do."

The other speakers were ex-Senator Albert A. Wray, who spoke on "Law and Science," and Frank K. Chew, who spoke on "Our Fame."

Entertainment of the Ladies

Advantage was taken of the presence of the ladies to arrange for several entertainments during the sessions of the society. On Wednesday, January 22nd, a trip was made to the Brooklyn Navy Yard, with a luncheon later at the Café Martin and the party then proceeded to the Hippodrome, where a matinée was witnessed. The ladies' committee consisted of Mrs. C. B. J. Snyder, chairman; Mrs. W. M. Mackay, Mrs. Hugh J. Barron, Mrs. John A. Connolly, Mrs. James A. Donnelly, Mrs. Thomas Barwick and Mrs. George B. England.

Among the visiting ladies were: Mrs. James Mackay, Mrs. James H. Davis, Mrs. John F. Hale, Mrs. S. R. Lewis, of Chicago; Mrs. Burt C. Davis, of Kansas City, and Mrs. Homer Addams, Allentown, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Board of Governors Organizes

At a meeting of the Board of Governors of the American Society of Heating and Ventilating Engineers on January 23rd last the board organized as follows:

Chairman, C. B. J. Snyder; vice-chairman, James Mackay; secretary, W. M. Mackay.

Finance committee: Wm. G. Snow, A. B. Franklin and Frank K. Chew; membership committee: James Mackay, E. F. Capron and R. E. Atkinson; publication committee: R. C. Carpenter, Wm. G. Snow and W. M. Mackay; executive committee: C. B. J. Snyder, W. M. Mackay and Frank K. Chew.

The Illinois chapter held its first regular meeting January 14th, in the rooms of the Western Society of Engineers, 1741 Monadnock Block. The officers of this chapter are: T. J. Waters, president; James Mackay, vice-president; John F. Hale, secretary; August Kehm, treasurer; board of governors: George Mehring, E. F. Capron and Samuel R. Lewis.

NATIONAL ASSOCIATION OF MASTER STEAM AND HOT WATER FITTERS

Next Annual Convention to Be Held in Washington

The nineteenth annual convention of this association will be held in Washington, D. C., May 21-23 next. Headquarters will be at the New Arlington Hotel.

President Gormly has appointed J. A. Almirall, of Evans, Almirall & Company, New York, a member of the Committee on Trade Relations, in place of E. B. Denny, of Newark, N. J., who has been made a member of the Board of Directors. The resignation of Arthur C. Walworth, as a member of the Committee on Standardization, is also announced, Thomas B. Cryer, of Newark, N. J., being appointed in his stead. E. M. Nichols, of Philadelphia, has been elected chairman of this committee.

American Foundrymen's Association.—The next convention of the American Foundrymen's Association will be held in Philadelphia, May 21-24, 1907.

THE HEATING AND VENTILATING MAGAZINE

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SO WIDE a basis exists for estimating rates for heating service from central stations that it is of interest to note the various methods of charging as enumerated recently by a writer on the subject in the *Municipal Engineering Magazine*. The usual method of measuring steam, passing through pipes, is, at this writer states, either by meter or by figuring from the amount of radiating surface it supplies. With steam as the heating medium, it is possible to come fairly close to a correct basis for estimating its cost. With hot water, however, the problem is more complicated because the variation in temperature of the heating medium is greater and, since the real thing desired is heat units, measurement of water without knowledge of its temperature or measurement of the heating surface without control of its temperature does not give all the information necessary for a charge which will be equitable under all conditions. The writer then reviews some of the systems of charging which have been in use and his remarks will be read with special interest by many in connection with recent discussions before the American Society of Heating and Ventilating Engineers.

THE first proposition, continues the writer, was perhaps the simplest, but the patrons must depend entirely upon the company for the sufficiency of their heat and for the price. In that case the rate charged was six cents per square foot of floor plan for a house one or two stories high, an extra charge being made for a third story. If the radiation was put in according to plans approved by the company a satisfactory temperature was guaranteed, and the only cost of increased radiation to the patron was the cost of installation. Rates were not unalterable and when the company thought it could not make money at six cents the rate was raised to seven cents and later to eight and one-third cents. A company with comparatively small patronage, operating under fairly uniform conditions, could satisfy its patrons fairly well, but if friction arose it would not be easy to adjust the difficulties, so much being left to the judgment of the operator of the plant.

ANOTHER early plan made a rate of one-third of a cent per cubic foot per year, the volume of the house to be determined by measuring length, width and outside height of house from top of foundation to ceiling of second floor. If the third floor of a house was heated a special rate was made for it, not exceeding the rate per cubic foot for the rest of the house. This rate is somewhat more equitable than the first, since it takes account of differences in height of ceilings, but it has the other defects of the former method of charging, except that the rates could not be changed unless the

change was authorized by the city council. This system was afterwards changed by consent of the city council and a charge of seventeen cents per square foot of radiation was authorized, provided the total charge for the house did not exceed one-half cent per cubic foot. Under this system the property owner must put in radiation enough to heat his house to his satisfaction and must pay for it at the seventeen cent rate, provided this does not exceed the half-cent a cubic foot limit. If, however, by reason of faulty design or contruction of his house, he is unable to make it comfortable with the amount of radiation expressed by the limit of the half-cent rate, the company must supply the additional heat without cost. On the other hand, if the water is not of adequate temperature when it enters the house, the patron must increase his radiation and pay for the same up to the half-cent limit. This system does not provide adequately for the inequalities referred to and neither company nor patrons are properly protected.

THE most popular system of charge seems to be a flat rate per square foot of radiation per year. The charge varies in various plants from twelve to twenty-five cents, the most popular rates being from seventeen to twenty cents and the average rate between those limits. One company makes its charge of twenty cents on cast-iron radiation, and counts a square foot of wrought-iron radiation as equivalent to one and three-eighths feet of cast iron. This system protects the company since the property owner, in order to make his house comfortable, must put in the amount of radiation needed to make the temperature suit his taste, and a man with a well-built house or who prefers a lower temperature can reduce his bill below that of a man with a loosely built house which he wishes to keep at a high temperature. It does not fully protect the patrons because it has no guaranty of the temperature at which the water will be supplied, or at the rate of flow of the water through his pipes. The most efficiently operated plants use regulators on each house connection which determine the rate at which the water shall pass through the house, and when the limiting temperatures of the regulator are properly determined and the apparatus adjusted therefor, any failure of the plant to supply water at the agreed temperature can be definitely determined.

ONE plant without these regulators attempted to guarantee that, if the radiation plans and amounts were approved by its superintendent, the temperature in the house should be at least seventy degrees when the thermometer outside stood at zero. In some cases this involved the increase of radiation at the expense of the property owner for the installation and without cost for the increased amount of heat furnished. In a few cases it resulted in too much radiation, but the patron could not secure a reduction in his bill, although he cut off a considerable proportion of his radiation. This plant went into the hands of a receiver, who decided that the increases in service were special contracts which he could not recognize and thereafter patrons were charged for all the radiation they had installed.

Ordinarily the flat rate per square foot of radiation has proved satisfactory, especially when patron and superintendent of plant work out the plan for the heating system together; but when there is bad management in the plant or a disposition to undue economy of service to patrons there should be some protection to them.

Sizes of Steam Mains

(*Discussion Continued from Page* 11)

WILLIAM J. BALDWIN: There has been one matter touched upon here to-night that I might throw some light upon, and that is the first formula mentioned by Mr. Donnelly, $R=D^2\times 100$. I believe I am responsible for it, as far as applies to heating apparatus, at least. I think it was in 1878 that I adopted it. It says here, "not figured for drop." It is rather late, after thirty years, to make an explanation, but I will say that in those days the practice was confined nearly altogether to gravity heating apparatus.

What I wrote then applied only to the construction of the gravity steam heating apparatus, and I am not sure that any material change can be made from the sizes then suggested, if the apparatus is to be successful. I did have a "drop" in mind when I adopted this rule, and those who will read my first book carefully will notice that my sizes for pipe diameters were intended to give a uniform drop for an apparatus and not for a unit of length of pipe.

All formulæ in which the square root of the fifth power of the diameter is considered relate to the drop that will take place in a given length of pipe, under a fixed condition. If this unit of length is 25 feet and the distance or length of the pipe is doubled, the drop is doubled, and if the pipe length is increased 100 times the unit, the drop is increased 100 times. Now, this rule in the hands of a mathematician will determine the conditions that should exist at all parts of an apparatus, whether its pipes be large or small or irregular. A careful engineer can also lay out a system of piping by the Weisbach formula and tell very closely what the "drop" at the various points will be and in modern apparatus, where steam is carried long distances, the engineer cannot work intelligently without it. Weisbach is credited with this formula and, if my memory serves me rightly, nearly everyone who has followed him on this subject has Weisbach for a foundation; but I believe when the matter was traced back to Weisbach, it was found that even he borrowed from somebody else.

There is one consoling thing, however, in the various formulæ given by Mr. Donnelly, such as D'Arcy, Unwin, Kutter, etc., that they so nearly agree for the smaller diameters. It must be borne in mind that should a man design a gravity apparatus by any one of these rules with the intention of having a uniform drop throughout the apparatus, that he may find by the time he has nearly equalized the pressure in his return pipes, at or near the water line throughout his entire apparatus, that he will have mains whose diameters near the boiler will be in excess of the diameters shown by the "Diagram of Carrying Capacities of Steam Mains with Various Formulæ" given in Mr. Donnelly's paper.

The first formula referred to in Mr. Donnelly's paper is the "straight-line formula," which is not, of course, in reality a straight-line formula. It simply happens to be represented by a straight line in his diagram, while each of the other formulæ is represented by a curved line. If the straight-line formula was properly represented, the radiating surfaces being equally spaced, it would be represented by a parabolic curve, and thus it is shown in the first edition of my book published about 1878. In a later edition of the book, in the same diagram, is shown a curve of the Weisbach formula; the curve of the square being for gravity apparatus for buildings when the horizontal distances were long, while the curve of half the fifth power is shown for mains of buildings whose ground area is small, but whose height may be great, calling for considerable radiation on short mains.

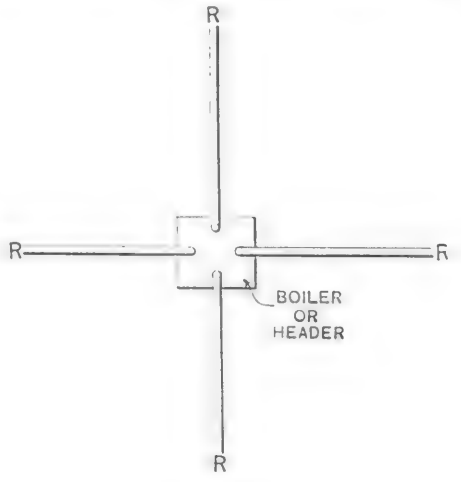


FIG. 1.

For exhaust steam-heating apparatus, where there is no water line or where the pressure at the water line is not material and where the entire endeavor is to proportion the mains of the apparatus sufficiently, so that the total resistance will not cause too great a back pressure (say 1 lb.), then the rule of the 2.5th power is good up to the point of the dissipation of the entire pressure that you command (say 1 lb. or ½ lb.). As soon, however, as the extremities of the lines begin to show a lack of appreciable pressure, then one of two things must be done. Either the mains must be increased in diameter near the source, or they must be increased in diameter at the extremities. Presumably, for equal distribution of pressure at all parts of the apparatus, the increase of diameters at the extremities would be best. In any case, the rule of the 2.5th power is de-

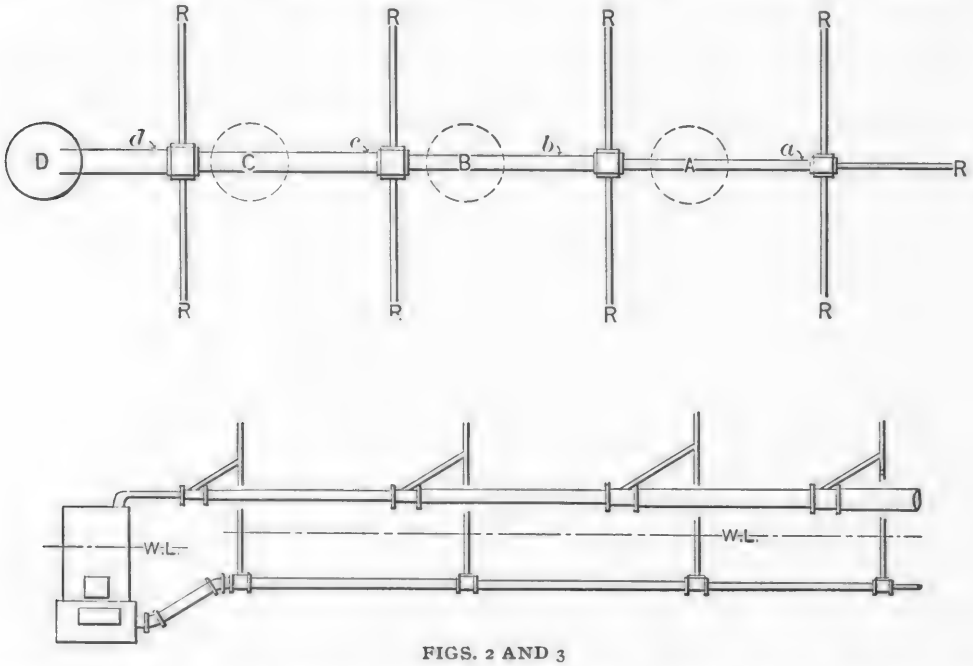
stroyed and the ideal formula has yet to be put forth.

The formula, therefore, of $R=KD^2$ was put forth with the idea that a constant drop, or nearly a constant drop, would exist throughout all gravity-heating apparatus. I intended to give sizes for mains of a gravity apparatus that would give ½ lb. loss of pressure between the boiler and the water lines in the apparatus, no matter how far they were from the boiler. The ½ lb. pressure, as you are aware, represents about 15 inches of hot-water column. My endeavor in those days was to give sizes, whereby the water in the vertical return pipes would not stand higher than 15 inches above the water line of the boiler. I had no means of giving careful scientific data nor had I the time. The most I could do was to put water glasses on the vertical return pipes, of various rising lines, in various heating apparatus, and note the losses of pressure at the various glasses. These losses were erratic. When the apparatus was in good running order, the radiators full of steam and the pressures steady, the water would subside in the glasses and mark a steady condition. When this condition was about 1 foot higher than the true water level in the boiler I found that the 1-inch pipe, for average building runs, would take care of 100 feet of heating surface with a loss of something less than ½ lb. of pressure (about 12 inches of hot-water column).

Fluctuations of pressure, however, such as always take place in a low-pressure steam-heating apparatus, supplied by a low-pressure boiler, complicated the matter. At times, on making a new fire, the pressure would drop down. When the new fire became active, the pressure increased. The reaction took place through the return pipes at once (they being full of water), while in the steam pipes there was a considerable loss of pressure due to the new steam hurrying through the pipes to fill the empty radiators. At such times the water would run up in the return pipes to a considerable height, often to 2 feet, and it was this fact that induced me to lay down a rule, "that the lowest part of any steam main of a gravity steam-heating apparatus should be at least 3 feet above the water line."

The normal condition of a gravity steam-heating apparatus, therefore, should be, that the water level in the poorest working return pipe should not stand more than 15 inches above the level of the water in the boiler. Under conditions of fluctuations of new fires, or starting the apparatus afresh, the water in the return pipes should not lift more than 2 feet above the water line in the boiler, the remaining foot being the "factor for safety" between the highest point in the return lines and the lowest point in thae steam mains. Pipes of an apparatus that will not give conditions equal to these are too small in diameter, no matter what rule they are worked out by.

The mains of a steam-heating apparatus may be likened to the branches of a tree. The smaller branches are to be fed by larger ones until we reach the



FIGS. 2 AND 3

great trunk. With the steam apparatus pressures should be constant and nearly equal at all points. Constancy we may obtain, but equal pressures we cannot. There will be some loss in transmission, no matter how large we start, unless, indeed, we make a "tank system" in which the boiler is the center, and we run from it for about equal lengths and for equal heating surfaces (Fig. 1). This will be a balanced system—balanced in pressure—if the mains are equal lengths and equal surfaces; but as soon as we change our length or our heating surface a new condition sets in and we are forced to the Weisbach formula and have various diameter pipes for the various conditions. The use of the Weisbach formula is impracticable for the ordinary steam fitter. At least, when the boiler has to be at one end of a building, and his mains become something like Fig. 2. Now, what he wants to know is how to find sizes for a condition like that shown in Fig. 2. If he places his boiler at A, all to the right of A become the mains of a small apparatus and the "drop" at the end of the three sub-divisions R, R, R, will be the same, provided the three branches R, R, R, are the same, regardless of the diameter of the pipe a. If the pipe a is small, the "drop" between the boiler A and the cross is great, but the distribution beyond this point is equal. Now, if a is made large the "drop" can be reduced to a negligible quantity and the cross is the distributing point, if you so desire.

Now move the boiler to B. The work is nearly doubled, as well as the distance, and if you are to keep up the pressure, the pipes b and a must be large—so large that the friction loss or "drop" is still negligible.

In like manner move the boiler to C and to D, and the trunk main a, b, c, and d should be made so large in diameter that the friction loss within it will be inconsiderable. If this is done, the points R, R, etc., will have nearly equal pressures, so that practically the pressure at each extremity will be the same.

One thing must be borne in mind, however, that no matter how large the trunk main d, c, b, and a is made, there will be some "drop," and this leads us to the question as to why it would not be better to reverse our main and put the small end to the boiler, as in Fig. 3. This will insure us a more equal distribution of both steam and pressure than our present practice. Of course you will say it is not practicable. I agree with you, although I desire to call your attention to the "loop of constant diameter" now so often practiced.

This is not turning the small end of the pipe to the boiler, but it is an effort to get equal, or nearly equal, pressures at all parts of the horizontal main, by maintaining the size of the pipe throughout its run.

To find the drop in this main circuit, the formula $R=D^{2.5}$ can be utilized; but when we get to vertical pipes, particularly one pipe rising lines, the velocities of the steam rather than the drop in pressure must be taken into consideration.

In connection with rising line sizes, you must follow something like the "straight-line formula" (in single pipe work, at least, if not in double), because the velocity of the steam passing up the riser has to be sufficiently slow so as not to carry up the condensed steam.

In working out a plant for any high building in New York, the horizontal main about the cellar can be laid out by any of these formulæ. When it comes to the rising line you must go by a formula that will not hold up the water. In branches from the rising line to the radiators larger pipes will be required.

I make the mains large and the rising lines large. As a result of investigations, I have come to the conclusion that when I get a velocity of 45 feet per second, in a rising line, I am reaching the danger point. At 50 feet I think I would reach it. When it comes to a horizontal pipe, connected with the radiator, I have found nothing to go by. A 1-inch pipe, however, I think, will take care of 40 square feet of radiating surface. One conclusion I came to in my experiments was that in the case of a horizontal pipe, a velocity of 15 feet per second is probably safe. In conection with the descent of water and condensation in a rising line, Mr. Donnelly assumes it falls in drops like raindrops, or even as large as a quarter of an inch in diameter. In my experiments with a glass rising line, I found water running in spirals and clinging to the pipe and at the end it would break away and come down in a shower or jet.

When I first noted what took place in a horizontal pipe, it appeared to me the stream and the water were running up the pipe, but as the radiator kept dry, I began to realize that the steam and water were not running up the pipe. The pipe was nearly one-third full of water. The steam passing up the pipe had some influence on the water coming down. There was a wave running along the top of the water in the pipe which make me think the water was not running out, but on getting close to it I noticed black specks moving in the opposite direction at rather a high velocity and near the bottom of the pipe—in other words, a return current.

Work has commenced on a central heating station in Spokane, Wash., which will be instructive to many engineers in the East, who are commencing to take an increased interest in this field of heating.

Ventilation of the Boston Subway.*

DISCUSSION

MR. L. H. WOODBRIDGE—In answer to anticipated inquiry with reference to certain methods and means employed for the ventilation of the Boston subway and tunnel, and which are not fully set forth in the interesting paper presented by Mr. Carson, a few additional statements are ventured which may be of sufficient general interest to warrant attention.

Several methods for ventilating the original subway were considered, one being that proposed by an alien engineer who advocated it as a sure, if not the only "positive" method. The method proposed was the reverse of that employed for ventilating the Liverpool-Birkenhead tunnel, namely: a properly proportioned airway built parallel with and in close proximity to the subway, with suitably spaced and dimensioned openings between that airway and the subway; the air to be supplied to the airway by a blower placed midway between stations, and the airway extending from that midway point in each direction toward and nearly to those stations. It was proposed by that method to secure a controllable distribution of fresh air along the entire length of the subway.

The method was not approved for reasons of cost, both of construction and of operation, and also because of inefficiency in the supply and the unsuitableness of the use of air in ventilating work.

A further reason which favors the entering of air at the stations and the removing of air at points midway between stations is that the air of the subway most breathed is that at the stations by the waiting crowds. Once in the car, if it be of the closed type, the air breathed is that of the car rather than of the subway proper. Furthermore, the change of air within closed cars is chiefly at stations, when doors are open and the passengers are in exit and entrance. The quality of air at the stations is therefore of more vital importance than is that of the subway except when open cars are in use.

The maintenance at the stations of the purest air practicable is additionally advisable because of the impression made on most users of the subway by the quick transition made from the outer to the inner air on entering the stations and when the olfactory senses are keen and any taint in the air entered is quickly detected. If on entrance the air is noticed as repulsive, a mental impression is made which is likely to be persistent, and to magnify and aggravate such defects as actually exist, and to find expression in private and public criticism and condemnation of atmospheric conditions in the subway.

In general, the minimum quantity of air which the mechanical system for the ventilation of the subway is planned to move is, as has been stated by Mr. Carson, equal to a flow of one linear foot per second from each station toward each center of discharge. The maximum speed of the fans was planned to be such as to discharge 50 per cent. in excess of the minimum quantity named. If the cross-section of the subway is 450 square feet, the minimum per minute air flow through the discharge fan, or fans, between stations should be 54,000 cubic feet, enough to supply 1,000 breathers with such reasonably pure air as to give a carbon dioxide increment of less than 2 parts in 10,000 of air. If a rise of five degrees of temperature be allowed, due to the transformation of mechanical into thermal energy, the corresponding rate in horsepower of work so transformed would be 115 between stations. Allowing an average electric input of ten horsepower to each car, eleven cars continually running between stations located 1,200 feet apart would be provided for.

A few words may be allowed with reference to the type of fan selected for the ventilating work. The two requirements governing the selection of fans for this purpose were, first, a minimum power expenditure, and, second, a minimum noise of action.

The choice lay between the standard cased blower type, the uncased radial, and the axial fan. Reference to a few of many tables compiled from the results of an extended series of tests made at the Massachusetts Institute of Technology on the performance of a variety of fans will aid to an understanding of the reasoning which led to the choice of the type used. (A table containing the figures of these tests accompanied Prof. Woodbury's discussion.)

A cursory examination of the table makes evident the well-established fact that the cased radial fan is the superior type for use when air is to be moved against any considerable pressure. No other would have been considered had the auxiliary airway method of ventilation been adopted.

The cased fan is not adapted to low-pressure work, for the reason that the pressure existing within the casing itself (and which is potent among the conditions producing flow through the fan orifice) is one against which the impelling fan must work.

(To be continued.)

*A paper upon this subject, by Mr. H. A. Carson, was read at the December, 1906, meeting of the American Society of Mechanical Engineers.

The Weather During January.

NEW YORK

In New York, the highest temperature recorded was 62° on the 7th, and the lowest, zero on the 24th. The greatest daily range was 24° on the 20th and the least daily range, 5° on the 14th. The mean temperature for the month was 32°, 2° above the average for this month for

37 years. There were 3.26 inches of rain and 11.7 inches of snow. The greatest amount of rain in any one day was 0.98 inch on the 12th. At the end of the month there were 3.8 inches of snow. The prevailing direction of the wind was northwest and the total movement, 9,060 miles; average hourly velocity, 12.2 miles; maximum velocity for 5 minutes, 59 miles per hour from the west on the 9th. There were 7 clear days, 9 days partly cloudy, 15 cloudy and 19 rainy.

CHICAGO

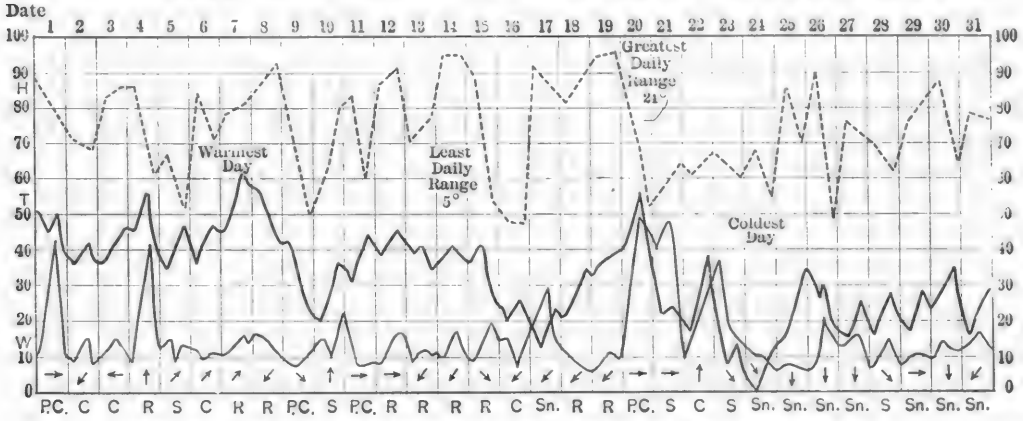
The highest temperature recorded for the month was 59° on the 7th and the lowest, 3° below zero on the 26th. The greatest daily range was 31° on the 8th and the least daily range, 3° on the 18th. The mean temperature for the month was 28°, 4° above the average for 37 years. During the month 4.21 inches of rain fell and 10.9 inches of snow. The greatest amount of rain in any one day was 1.80 inches on the 18th-19th. At the end of the month there were 3.1 inches of snow. The prevailing direction of the wind was northwest, total movement, 10,662 miles; average hourly velocity, 14 miles; maximum velocity for 5 minutes, 60 miles per hour from the west on the 20th. There were 6 clear days, 5 partly cloudy, 20 cloudy and 19 rainy.

ST. LOUIS

In St. Louis, the highest temperature was 67° on the 7th, and the lowest, 6° on the 26th. The greatest daily range was 34° on the 8th, and the least daily range, 7° on the 1st. The mean temperature for the month was 36°, 4° above the average for 34 years. The total rainfall was 7.35 inches, and the snowfall, 2.8 inches. The greatest rainfall in any one day occurred on the 14th-15th, when 1.69 inches were recorded. At the end of the month there was no snow. The prevailing direction of the wind was south; total movement, 8,051 miles; average hourly velocity, 10.8 miles; maximum velocity for 5 minutes, 52 miles per hour from the west on the 19th. There were 7 clear days, 7 partly cloudy, 17 cloudy and 16 rainy.

BOSTON

In Boston, the highest temperature recorded was 58° on the 20th, and the low-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Greatest Daily Range 21°
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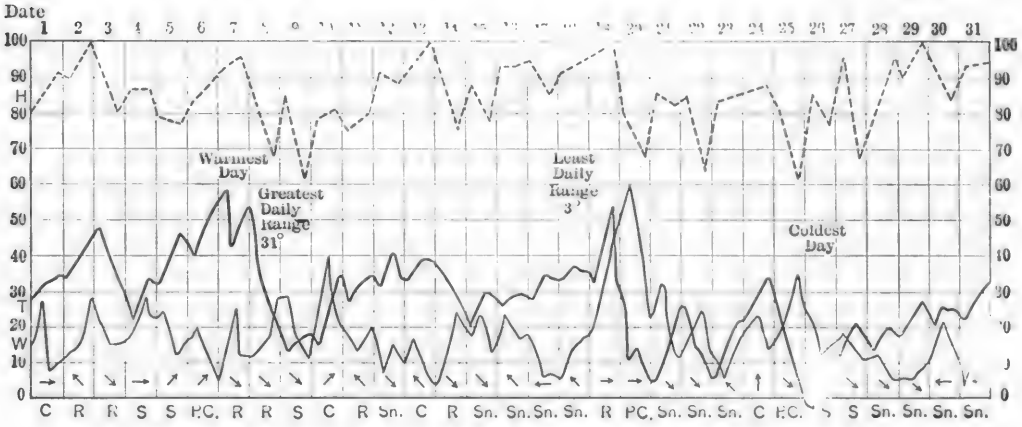
RECORD OF THE WEATHER IN NEW YORK CITY FOR JANUARY, 1907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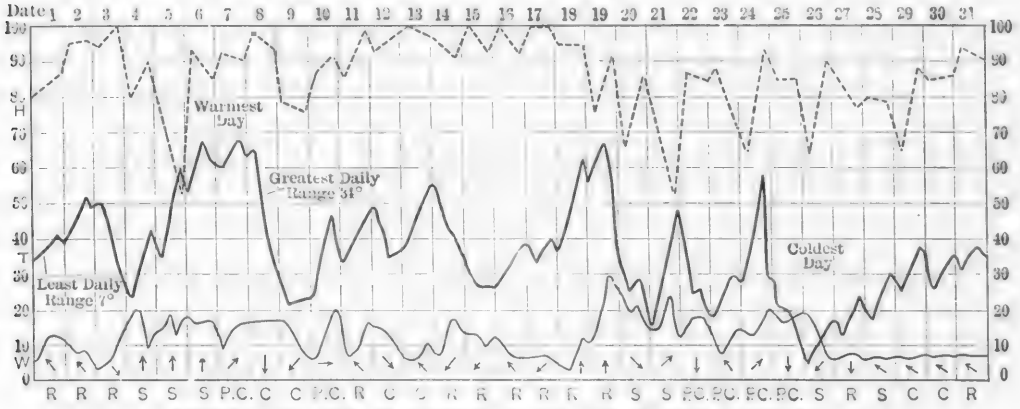
RECORD OF THE WEATHER IN CHICAGO FOR JANUARY, 1907

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage
Lower black line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind.
S—Clear. PC—Partly Cloudy. C—Cloudy. R—Rain. Sn.—Snow

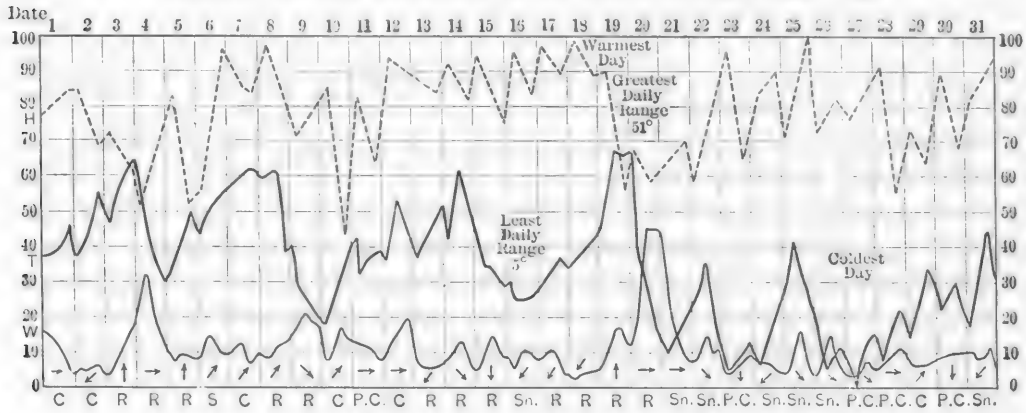
est, 7° below zero on the 24th. The greatest daily range was 26° on the 18th, and the least daily range, 4° on the 8th. The mean temperature for the month was 27°, being the same as that for the last 37 years. The total rainfall for the month was 2.54 inches, and the snowfall, 16.1 inches. The greatest rainfall in any one day was 0.78 inches on the 25th-26th. At the end of the month there was 6.9 inches of snow. The prevailing direction of the wind was northwest and the total movement, 7 953 miles; average hourly velocity, 10.7 miles; maximum velocity for 5 minutes, 36 miles per hour from the northwest on the 9th. There were 4 clear days, 7 partly cloudy, 20 cloudy and 16 rainy.

PITTSBURG

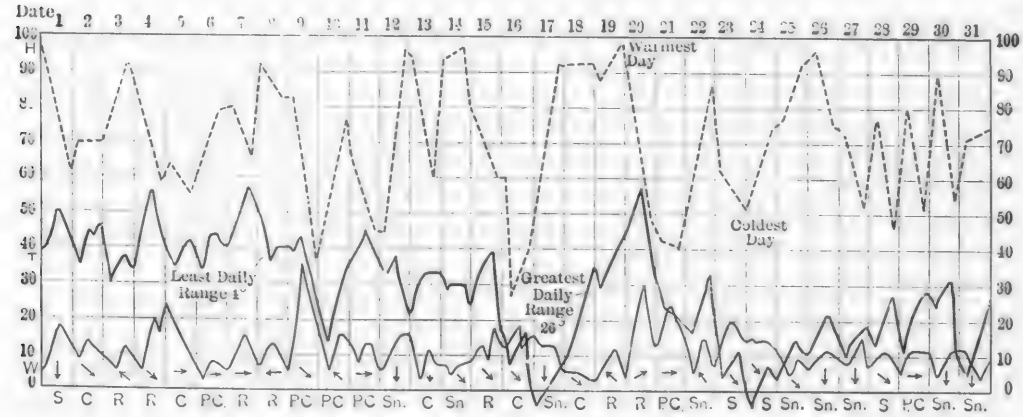
The highest temperature for the month was 69° on the 19th, and the lowest, zero on the 27th. The greatest daily range



RECORD OF THE WEATHER IN ST. LOUIS FOR JANUARY, 1907



RECORD OF THE WEATHER IN PITTSBURG FOR JANUARY, 1907



RECORD OF THE WEATHER IN BOSTON FOR JANUARY, 1907

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage
Lower black line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind
S—Clear. PC—Partly Cloudy. C—Cloudy. R.—Rain. Sn.—Snow

was 51° on the 20th, and the least daily range, 5° on the 16th. The mean temperature for the month was 35°, being 4° above the average for 37 years. There were 5.58 inches of rain and 12,7 inches of snow. The greatest amount of rain in any one day was 0.97 inches on the 12th. At the end of the month there were 4.8 inches of snow on the ground. The prevailing direction of the wind was northeast, and the total movement, 7,894 miles; average hourly velocity, 10.6 miles; maximum velocity for 5 minutes, 62 miles from the west on the 20th. There were 3 clear days, 7 partly cloudy, 21 cloudy and 20 rainy.

The Sanitation of Air.

In an article on "Sanitation of Air," by Mr. Konrad Meier, of New York, which appears in the January issue of the *Popular Science Monthly*, the writer reviews in an interesting manner the subject of impure air, its bearing on health, with a general discussion of heating and ventilating systems. On the subject of the smoke nuisance he says:

"Smokeless combustion is not only feasible for almost any kind of coal, but more economical if properly attended. The principal difficulty exists in the design of the proper furnace to suit the fuel and to meet the conditions under which it is burned. There ought to be no restriction on the use of bituminous or any other coal. On the other hand, no excuse should be accepted for black smoke from any source within city limits. If not willing or able to suppress it, the offensive industry must be made to move. But all the smaller and innumerable sources of medium, light and invisible smoke should also receive attention. They emit, in reality, by far the largest share of it in the average commercial and residential community, less noticeable because more diluted, but none the less objectionable. The reduction of this smoke is, for practical reasons, beyond control of local health authorities, but it can gradually be eliminated through individual action; that is, by the general concentration of light, heat and power service. The movement in this direction was started long ago with the introduction of central stations for light and power, but it is capable of much greater extension, particularly for heating and power. The bulk of the fuel should be burned at the mine, or at tide-water outside of city limits. Such concentration of combustion for various needs represents a material saving in the total amount of fuel consumed, and, therefore, of the smoke produced. It would incidentally avoid the handling of much coal and ashes and reduce the large amount of exhaust steam now seen pouring away from the numerous individual plants in certain neighborhoods. On still days these vapors contribute perceptibly to the murkiness of the atmosphere. The use of steam power for transportation in urban and densely populated suburban districts has long since ceased to be a necessary evil and should have been prohibited years ago. It is gratifying to state that at last this much-needed economic and sanitary reform seems about to be realized."

National Steel Tube Cleaner.

An interesting feature of the National steel tube cleaner, illustrated herewith, is that each blade acts independently of the others and is so springlike in nature that it conforms very snugly to the surface which is to be cleaned. It can be forced through the tube with very little effort and each plate removes the particles of sediment or scale within the pipe. Another advantage of this cleaner is that it can be adjusted to fit various sizes of pipe and if one or more of its blades become broken by rough usage or wear they can be repaired at nominal expense. The device is manufactured by the H. W. Johns-Manville Company.

THE NATIONAL STEEL TUBE CLEANER

Books Received.

MODERN PLUMBING ILLUSTRATED, by R. M. Starbuck, 10½x7¾ inches, pages 392. Price, $4.00. New York: The Norman W. Henley Publishing Company.

This recent work on methods of plumbing construction is designed for the use of plumbers, architects, builders, property owners and for boards of health and plumbing examiners. It is illustrated by 55 full-page plates. Especial attention is given to the questions of drainage and sewerage. On these questions the author has followed the requirements of New York and other important cities, as well as the requirements of the United States Government. The book will prove a valuable addition to the literature on this subject.

TRADE AND MISCELLANEOUS NOTES

Miscellaneous Notes

H. W. Johns-Manville Co., New York, held the annual meeting of its sales staff during the week ending February 2nd. Representatives were present from the company's factories in Brooklyn, Milwaukee, West Milwaukee, and Hartford, Conn. Also from the branch offices at Milwaukee, Chicago, Boston, Philadelphia, St. Louis, Pittsburg, Cleveland, San Francisco, Los Angeles, Seattle, Kansas City, Minneapolis, New Orleans, Dallas and Buffalo. A feature of the convention was a dinner at the Waldorf-Astoria, New York, on the evening of Feb.

W. A. Davis, formerly organizer for the National Association of Master Steam and Hot Water Fitters, has accepted a similar office with the National Association of Boot and Shoe Manufacturers.

Home Builders' Exhibition is the official title of a show that will be given at the Grand Central Palace, New York, from May 4th to May 11th next, by the Real Estate Exchange of New York City. In the preliminary announcement of the exhibition it is stated that its scope will include every raw and manufactured product that enters into the constructive fabric of the modern dwelling, but will not include articles of ordinary character which possess no special feature adjuncts and surroundings. It will be the first exhibition of its kind held in this country, and heating appliances will have a conspicuous place in the display. Otto Kempner, general manager, 349 Fifth Avenue, New York, has charge of the arrangements for space.

Asbestos, prior to 1850, was looked upon principally as a curiosity, although Charlemagne (Roman Emperor from 800 to 814 A. D.) is said to have had a tablecloth made of asbestos, which he cleaned by throwing into fire. There are two varieties of commercial asbestos, known as Amphibole and Chrysotile. The former is used only to a comparatively small extent, as the fibers are short and without tensile strength and are, therefore, not suitable for manufacturing many of the asbestos products. Amphibole is used to some extent in cements, but is not well adapted even for that purpose. Chrysotile, on the other hand, has a strong and silky fiber, which adapts it for such materials as asbestos fabrics, household utensils, theatre curtains, clothing for firemen, etc. In Germany, asbestos is known as steinflachs (stone flax) and the miners of Quebec give it quite as expressive a name—pierre coton (cotton stone). Asbestos is mined in open pits, similar to stone quarries, and although it is found in all parts of the world, the mines in Quebec, Canada, are the most famous, yielding about 85 per cent. of the world's supply of chrysotile. Probably the largest of these mines is that owned by the H. W. Johns-Manville Co. of New York. In 1879 the output of the Quebec mines was 300 tons, which has steadily increased year by year to 50,000 tons in 1905.

L. G. McCrum and George D. Howell, of the McCrum-Howell Company, New York, figure in the sale, recently consummated, of 2,000 acres of coke land in western Pennsylvania. These gentlemen negotiated the deal for the transfer of the property from J. V. Thompson and asso-

The Albany Return Steam Traps

have been the **STANDARD** for over **THIRTY-TWO YEARS.** For returning water under pressure to the boiler, they will perform this duty fully as well, and in many cases better than the so-called steam loop.

Send for circulars A, B, C and D.

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FREDERICK TOWNSEND, PRESIDENT

JAMES H. BLESSING, GEN. MGR

ciates to the Tower Hill Connellsville Coke Company, of which they are both members. The company will build 1,000 ovens for the manufacture of coke. The deeds were recorded January 29th last and the title passed on that day. The price for the entire property was about $3,400,000. George D. Howell has been made president of the coke company and Lloyd G. McCrum a director.

Trade Literature.

Western Tube Co., Kewanee, Ill., in a recently issued circular, describes the male and female Kewanee union. Referring to the advantages of this union, it is pointed out that in practically all places where a union is desired the connection is made with a tee elbow valve or some fitting having a female opening and, when an ordinary union is used, a nipple of the proper length must be secured in making the connection. When the Kewanee union is used, no nipple is necessary, as the connection is made direct with the male end of the union.

Buffalo Forge Co., Buffalo, N. Y., in a recently issued leaflet, mentions the following "cardinal virtues" of the Buffalo air washer and humidifier:

Removes all dust and smoke from the air entering a ventilation system. Regulates the humidity prevailing in the atmosphere of a building, keeping it at any relative percentage that may be desired. Gives added economy due to the higher sensible temperature. Reduces the temperature in summer over 80 per cent. of the initial difference in temperature between the air and the cooling water used. Resistance less than coke and cheesecloth screens or any other type of filter; less than one-tenth of an inch of water. Requires no attention or adjusting; it operates continuously and entirely automatically. Results: pure air conditions for ventilation systems; low temperature drying where high temperature is not allowable in industrial applications; humidity automatically regulated.

Manufacturers' Notes

New York Blower Co., Bucyrus, Ohio, are planning to build a new plant at that place. Work will be begun early in the spring.

Niagara Radiator Co., North Tonawanda N. Y., held a meeting of its larger creditors January 7th last. At this meeting it was found that the assets of the company were about $362,000 and the liabilities, $211,533. Mr. McNab, secretary of the meeting, was made temporary receiver of the company and was requested to begin operating the business as soon as he could receive sufficient money on receiver's certificates. It is expected that enough new capital can be obtained to

BOOKS ON HEATING AND VENTILATING

Heating and Ventilating Buildings

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A standard manual for heating engineers and architects. Includes chapters on exhaust steam heating and heating with electricity.

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Contains descriptions of steam heating apparatus for warming and ventilating large buildings and private houses, with remarks and tables.

Questions and Answers on the Theory and Practice of Steam and Hot Water Heating

By R. M. STARBUCK. 90 Pages. Pocket size. Illustrated. Cloth, $1.00.

A handy book for the steam fitter, containing tables and data, rules, and "tricks of the trade."

Mechanics of Ventilation

By GEORGE W. RAFTER. Pocket size. Boards, 50c. New and revised edition.

Modern Sanitary Plumbing, Steam and Hot Water Heating

By JAMES J. LAWLER. 400 Pages. 288 Illustrations. Size, 6x9 inches. Price, $5.00.

This is the latest edition of Mr. Lawler's well known work on this subject.

Notes on Heating and Ventilation

By JOHN R. ALLEN. 152 Pages. 34 Illustrations. Size, 4½x6¼ inches. Cloth, $2.00.

One of the new books, brought quite up to date, and containing much information to guide the intelligent steam fitter in the installation of heating and ventilating apparatus.

Ventilation of Buildings

By WILLIAM B. SNOW and THOMAS NOLAN. 83 Pages. Pocket size. Boards, 50c.

Just out. Contains a statement of the general principles of ventilation and of their application to different kinds of buildings.

Chimneys for Furnaces and Steam Boilers

By R. Armstrong. Pocket size. Boards, 50c.

Third American Edition. Revised and partly rewritten, with appendix on Theory of Chimney Draft, by F. E. Idell.

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1123 Broadway, New York

enable the company to continue its business. Associated with Mr. McNab is an advisory committee, consisting of George H. Clune, of the Adrian Furnace Company; Harry Yates, of the Rochester & Pittsburgh Coal and Iron Company; W. D. McKeefrey, of McKeefrey & Co.; Robert L. Cox and R. L. Ginsburg, of A. L. Ginsburg & Sons.

Garwood Foundry & Machine Co., Garwood, N. J., have opened a Philadelphia office at 18 South Seventh Street, with Norris W. Bing in charge.

Curtis & Curtis Co., Bridgeport, Conn., will again enlarge its plant, the addition being a modern machine shop to cover about 6,000 square feet of floor space.

Hart & Crouse Co., Utica, N. Y., has appointed R. B. Hunt manager of the New York office at 235 Water Street. Mr. Hunt has been connected with the H. B. Smith Company as traveling representative. He was previously connected with Frank Dobson, heating engineer and contractor in New York, and also with the American Radiator Company, in New York.

Borden Co., Warren, Ohio, have started the erection of a new plant, to be used only for the manufacture of hand and power pipe threading machines. The building will be of brick and structural iron and one story high.

A. F. Gartz, the newly-elected president of the Central Foundry Company, has removed to New York from Chicago.

Central Foundry Company, New York, announces the appointment of C. G. Beach to the management of its pipe department. Mr. Beach succeeds Mark Dean, who will devote his time to his other interests.

National Tube Co., Pittsburg, Pa., has orders for 30,000 tons of 10-inch steel pipe to be forwarded to Burmah for the Burmah Oil Company, which operates the extensive oil works of Upper Burmah. The total length of the pipe line, including the branches, will be 328 miles. This is the largest single order for wrought-iron pipe ever placed in this country for shipment abroad.

H. W. Johns-Manville Co., New York, has the contract for covering with their J-M asbestos roofing the buildings of nearly the entire plant of the North American Manufacturing Company, pottery manufacturers, at Newhall, W. Va., a new town on the Ohio River, opposite East Liverpool, O. The order calls for several thousand squares of the material.

Crane Co., Chicago, Ill., announces that its new steel foundry is now in full operation.

Thomas P. Ford Co., New York, has removed its offices from 81 Centre Street to 407 Broome Street.

H. W. Johns-Manville Co., New York, has established a branch office at New Orleans, the local address being 353 Barrone Street, and another branch office at Buffalo, N. Y., located at 214 Main Street.

Post yourself on Vacuum Heating

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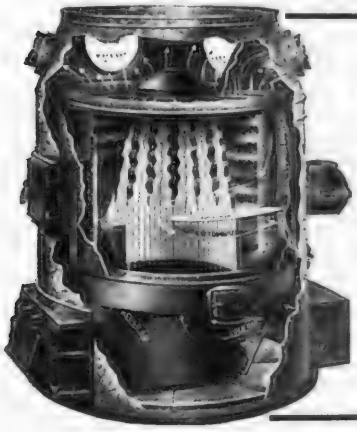

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New York Office, 156 Fifth Ave.

Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y., held its annual meeting February 4th last, when the following directors were elected: William K. Pierce, William R. Butler, H. C. Pierce, William M. Butler and Thomas Wheatley. The following officers were elected: President and general manager, William K. Pierce; vice-president and treasurer, Thomas Wheatley; secretary, P. M. Beecher; assistant treasurer, F. W. Fix, Jr. President William K. Pierce reported a very satisfactory business and perfectly harmonious relations with labor in the various manufacturing departments of the company. Many new projects are in view for the further development of this business and the company looks forward to a most prosperous year.

McCrum-Howell Co., New York, announce, under date of February 1st, 1907, an advance of 10 per cent. on the price on all repairs for Richmond boilers and furnaces.

Buffalo Forge Co., Buffalo, N. Y., has changed the location of its Cleveland office from 311 Citizens Building to 618 Citizens Building.

Gorton & Lidgerwood, 96 Liberty Street, New York, are showing to many interested inquirers a model heating plant in operation at their main office, equipped with the Gorton vapor vacuum system of heating.

Business Changes

W. A. Russell & Co., Waterbury, Conn., has removed its main office from this place to 89-91 Centre Street, New York.

Nelson and Anderson Plumbing & Heating Co., Red Wing, Minn., has taken over the business of Charles Nelson.

New Firms

Paddock, Kenyon & Montgomery, Sycamore, Ill., is the name of a new firm which will carry on a general heating, plumbing, metal working and gas fitting business.

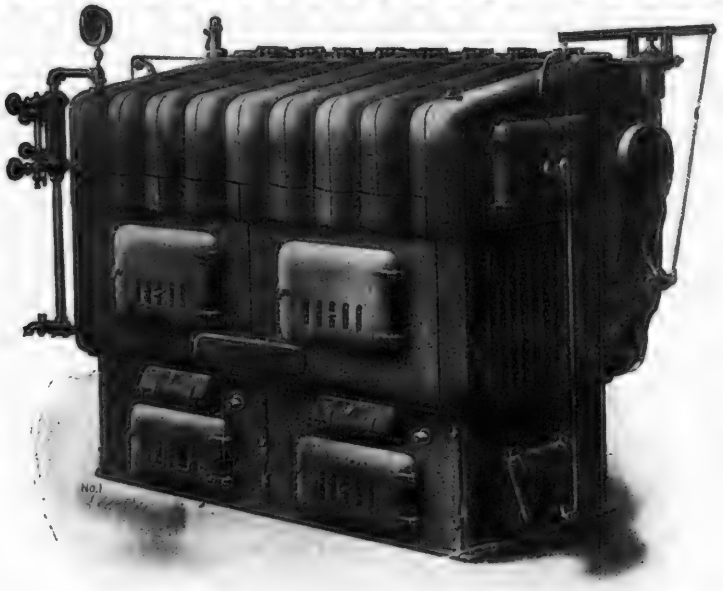
Baltimore Vapor Heating & Contracting Co., Baltimore, Md., is the title of a new heating company at that place. Christopher Lauterbach has been made manager of the firm.

C. A. Ryerson, C. L. Rosevear, T. M. Arnold, T. Shepard and W. M. Weeks, Toronto, Can., have formed a company to manufacture heating apparatus and deal in plumbing goods. The capitalization is $100,000.

Iowa Radiator Co., Cedar Rapids, Ia., is the name of a new firm which will erect a plant here early in the spring for the manufacture of house heating boilers and radiators.

Globe Heating & Construction Co., Baltimore, Md., is a new firm located at

BERNHARD BOILERS



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The ONLY Boiler fired from the side that the fire travels three times its length.

The ONLY Boiler with a 50 in. Waterline with a capacity up to 12,000 sq. ft.

The ONLY Boiler above 2500 feet capacity that is only 3 ft. to rear end of grate.

Western Representatives
Murphy-Dugger-Clark Co.
157 Lake St., Chicago, Ill.

THE GARWOOD FOUNDRY & MACHINE CO.
GARWOOD, N. J.

Boston Representatives
The Wm. H. Gallison Co.
36 Oliver Street

621 13th St., N.W., WASHINGTON, D. C.
The Builders' Exchange, PHILADELPHIA, PA.

314 West Pratt Street. H. J. Rumpf and C. N. Joyce, Jr., are at the head.

Hazen Manufacturing Co., Hudson, Mich., has been formed for the purpose of manufacturing pumps. The officers are: L. R. Hazen, president; W. S. Hazen, vice-president; G. H. Loyster, secretary; Arthur Green, treasurer; W. E. Keister, general manager.

New Incorporations

Denslow Heating Co., Waverly, N. Y., has been incorporated to manufacture Denslow furnaces and heaters. The directors and officers are: Hon. B. L. Winters, president; W. H. Denslow, vice-president; W. E. Chase, treasurer and manager; John H. Murray, secretary; and Dr. Ellsworth Gamble.

American Perfection Combustion Heating Co., Evanston, Wyo., has been incorporated with a capital of $500 000.

New York Heater & Supply Co., 160 Fifth Avenue, New York, has been incorporated to manufacture boilers, radiators, valves and air valves and heating specialties. President, W. S. Newkirk; secretary-treasurer, E. E. Ward.

Car Ventilating & Heating Co., Boston, Mass., has been incorporated with a capital of $250,000 to deal in machinery and heating apparatus. The directors are: Albert E. Knowlton, T. H. Hathaway, J. W. Haines and C. C. Smith.

O'Donnell Steam Heating Co., Evansville, Ind., has been incorporated with a capital of $5,000. The incorporators are: John O'Donnell, August Kering and H. C. Stevens.

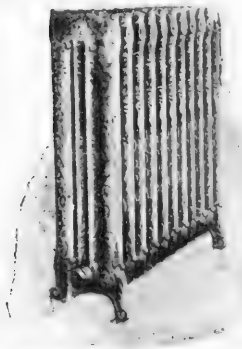
Giant Heater Co., Springfield, Mass., has been incorporated with a capital of $100,000. The incorporators are: Wilbur R. Young, George M. Faulkner and Henry H. Caswell.

W. H. Hobbs Supply Co., Eau Claire, Wis., has been incorporated with a capital of $60,000. The incorporators are: W. H. Hobbs, E. A. Carroll and A. J. Marsh.

Open Coil Heater & Purifier Co., Indianapolis, Ind., has been incorporated with a capital of $50,000. The directors are: Cole Stickle, Celia A. Stickle, William Lightford and John G. Forster.

Backert & Shroder Steam Heating Co., Brooklyn, N. Y., has been incorporated to conduct a steam and hot water heating business. The incorporators are: J. C. Backert, G. W. Shroder and G. V. Gunderman.

William A. Seddon Heating & Plumbing Co., Columbus, Ohio, has been incor-



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BUNDY STEAM AND WATER RADIATORS

No element of risk enters with the purchase of these old-time, tried and reliable goods. A complete new line of patterns and other equipment built during the past year enables you to buy our sectional radiators in one, two, three, and four column, plain and ornamental—all heights.

By the way—did you receive a copy of that new trade catalogue we are mailing out? If not, send name and address.

BUNDY BOILERS, Cast Iron Sectional, Steam Traps, Oil Separators, Valves and Air Valves, are all worthy of your attention.

Bundy—Stateroom

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porated with a capital of $10,000. The incorporators are: William A. Seddon, Charles Seddon, Edwin Poulton, Malcolm A. Harschner and Henry A. Williams.

Portable Parallel Hot Water Radiator Co., Washington, D. C., has been incorporated with a capital of $50,000 to manufacture radiators. The incorporators are: Alfred B. Leet, Elias R. Levy, Frank H. Wheelock and John H. Clapp.

Goshen Plumbing & Heating Co., Indianapolis, Ind., has been incorporated with a capital of $10,000. The directors are: Charles E. Kutz, Josie M. Kutz and Daniels Riggle.

Light, Heat & Power Co., Newcomerstown, Ohio, has been incorporated with a capital of $25,000. The incorporators are: R. L. Shoemaker, Henry Hess, Beatrice Shaw, C. Casparis and Thomas S. Brooks.

Vacuum Burner Co., Buffalo, N. Y., has been incorporated with a capital of $10,000 to manufacture vacuum burners for use under boilers, furnaces, etc. The directors are: B. H. Wilson, Eugene C. Waldorf and Greenleaf Van Gorter.

Brock Heater Co., Alma, Mich., has been incorporated with a capital of $20,000.

Automatic Water Heater Co., Rockford, Ill., has been incorporated with a capital of $10,000. The incorporators are T. W. Pitcher, R. F. Locke and E. E. Stockburger.

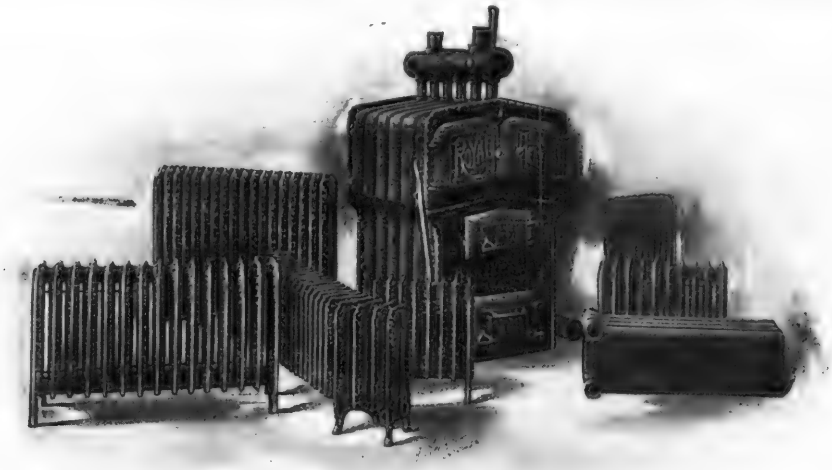
Long Island Heating Co., Brooklyn, N. Y., has been incorporated with a capital of $10,000. The directors are: Edwin F. Singer, E. J. Olmstead and W. E. Baker, all of Brooklyn.

Morton Light, Heat & Water Co., Morton, Ill., has been incorporated with a capital of $18,000. The incorporators are: Henry Beyer, Moses S. Beyer and Frank Beyer.

Lookout Steam Heating & Supply Co., Chattanooga, Tenn., has been incorporated with a capital of $10,000. The incorporators are: Leo Strahler, R. P. Woodward, B. E. Hodge, D. N. Marshall and H. H. Peck.

Chances for Business

St. Joseph, Mo.—An independent heating, lighting and refrigerating plant, to cost $12,000, is to be installed in the Hotel Metropole. W. K. Palmer & Company, of Kansas City, are the consulting engineers and will advertise for bids on the work soon.



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Minneapolis, 742 Lumber Exchange.

Rogers, Ark.—A steam heating plant will be installed at the Rogers Academy, costing about $2,500.

Pittsburgh, Pa.—Bids will be received by Bollinger Brothers, engineers, Fulton Building, in March or April, on the heating, plumbing and refrigerating for the $200 000 brewery at Sharpsburg, Pa., and the Fort Pitt Brewery Company, Pittsburg, Pa.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect until 3 P. M., February 26th, for the construction of the superstructure—including heating apparatus, plumbing, gas piping, electric conduits and wiring—of the U. S. Post Office, at Kingston, N. Y.

Philadelphia, Pa.—Estimates will be received by John T. Windrim, architect, for the eight-story building, 60x200 feet, to be built on the northwest corner of Eleventh and Market Streets and costing about $300,000.

Contracts Awarded.

Engleby & Brother Co., Roanoke, Va., heating the Stone Printing and Manufacturing Company's new building.

Rawson-Greenbend Co., Owen, Wis., heating the new school building.

Pennsylvania Plumbing & Supply House, Jeannette, Pa., heating the new six-story Swank Office Building at Johnstown.

American Foundry & Furnace Co., Milwaukee, Wis., installing the heating plant in the new $80,000 Methodist Church.

Cleveland Steam Fitting & Supply Co., Cleveland, Ohio, heating the new residence for F. W. Bruch.

Royal Heating Co., San Francisco, Cal., installing a vacuum heating plant in the Hotel Clermont.

A. J. Rundel, Iron Mountain, Mich., heating the schoolhouse at Channing.

William H. Long, Huntingdon, Pa., steam heating the new department store building built by Shapiro Brothers, at Orbisonia, Pa.

Moline Heating & Construction Co., Moline, Ill., installing the vacuum steam heating system in the Sacred Heart Belgian Catholic Church.

Hurley & Co., St. Paul, Minn., heating and plumbing the new company barracks in Fort Meade, S. D.

C. W. Saunders, West Newton, Pa., heating the new Elliott building.

Downey & Kruse Co., Milwaukee, Wis., installing the heating plant in the court house and county jail, at their bid of $16,199.

W. F. Ackinclose, Wilmerding, Pa.,

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The J. L. Mott Iron Works

Fifth Avenue and 17th Street, New York

BOSTON CHICAGO DENVER SAN FRANCISCO

heating and plumbing the addition to Hotel Fritsch at East Pittsburgh.

Carson-Payson Co., Danville, Ill., heating the new Citizens' National Bank Building.

Sawyer & Dean, Haverhill, Mass., heating and ventilating the new Wingate school.

Trotter Brothers, Altoona, Pa., hot water heating the Christie Mercantile and Office Building.

J. S. Goodenow, Utica, N. Y., ventilating and plumbing a large school at Glen Cove, L. I.; also a school at Greenwich, Conn.

Furman & Oles, Lewiston, Pa., heating and plumbing the N. W. Staylor business block.

Kansas City Steam and Hot Water Heating Co., Kansas City, Mo., installing large sectional steam boilers in the John Moore Hotel and the George Moore Turkish bath-house.

McClenahan Brothers, Reedsville, Pa., steam heating the new Belleville National Bank Building, Belleville, Pa.; also heating and plumbing the Milroy National Bank Building at Milroy, Pa.

The Walworth Construction & Supply Co., Boston, Mass., heating the new Crescent Street school, which will cost about $100,000.

Alan Black & Co., St. Paul, Minn., installing a heating plant in the Superior Building, at Duluth, Minn.

Korsmeyer Co., Lincoln, Neb., heating and plumbing the Temple Building.

Pond & Hasey Co., Minneapolis, Minn., heating the new Rudolph Giselius Hotel at Valley City, N. D.

W. W. Watson, Los Angeles, Cal., steam heating, plumbing, gas fitting and sewer work in their three-story reinforced concrete apartment building. The contract amounts to $6,365.

Smollen & Schoenleben, Milwaukee, Wis., heating the addition to St. Mary's Hospital in Racine, Wis.

H. T. Keim, Newport, Pa., steam heating and plumbing the new apartment building for M. C. Ficher.

French & Hubbard, Boston, Mass., steam heating, electrical and sanitary work in the new Museum of Fine Arts Building.

Lewis & Kitchen, Kansas City, Mo., heating the new Morse school. The temperature regulating apparatus will be furnished by the National Heat Regulation Company, of Chicago, Ill.

Hahn & Rowe, Frederick, Md., heating the new Y. M. C. A. Building; also heating and plumbing the Y. M. C. A. Building in Brunswick, Md.

Elway & Chamberlain, Altoona, Pa., heating the new Altoona Market House.

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P. F. Maginn & Co., Pittsburg, Pa., heating the new mercantile building for the Hartley-Rose Belting Company.

J. S. Sutherland, Rochester, Pa., heating fourteen new residences at Aliquippa, Pa.

Caldwell, Semple & Co., Sharon, Pa., steam heating the store and apartment building being built for Pierce & Krantz, Sharpsville, Pa.

Peck-Hammond Co., Cincinnati, Ohio, heating the Louisiana Odd Fellows Home at New Orleans. The contract is worth about $1,200.

Regan & Hormel, Charleroi, Pa., heating the new Cumberland Presbyterian Church.

Johnson & Feiring, Galesville, Wis., installing a heating plant in the new Commercial Hotel.

John G. Sutton Co., San Francisco, Cal., heating the four-story and basement brick building at Elis and Leavenworth Streets. The consideration is $4,760.

Campbell-Laird Heating Co., Minneapolis, Minn., installing a warm-air heater in H. M. Clark's residence, Rockford, N. D., also in Russell Brothers' store building, Minneapolis, Minn.

Eddy Engineering Co., Alpena, Mich., steam heating the new hotel at Harrisville.

John G. Sutton, San Francisco, Cal., installing the hot-water system and steam heating boilers, piping and radiation in Wells, Fargo & Company's eight-story building. The consideration is $15,400.

H. R. McDonald, Nashua, N. H., heating the Telegraph block.

Raisch-Dodge Co., San Francisco, Cal., heating and plumbing the new Call Building and also the residence of Claus Spreckels

F. W. Pripps, Milwaukee, Wis., heating the new factory building for the Carbolineum Wood Preserving Company.

Frontier Plumbing & Heating Co., Buffalo, N. Y., hot-water heating the engine and truck house at Washington and Tupper streets. Their bid was $1,219.

C. Hurley, Iowa City, Ia., heating the new Baptist Church.

Gray & Suter, Fulton, Mo., heating and plumbing T. N. Sake's department store at Higginsville.

Armitage Bros., New Kensington, Pa., hot-water heating the new $15,000 residence for R. A. Withers, Parnassus, Pa.

Rufe Bros., Philadelphia, Pa., installing a two-pipe circuit steam-heating plant in the church at Twenty-fourth street and Lehigh avenue. The contract is worth $1,100.

W. B. Connelly & Co., Pittsburg, Pa., steam heating and plumbing the $25,000 passenger station at Braddock, Pa., for the Baltimore & Ohio Railroad.

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V. Yausche, La Crosse, Wis., heating the new school building in La Crescent, Minn.

W. A. Bridgman, Bristol, Tenn., steam heating and plumbing a new six-story office building.

William A. Heckman, Reading, Pa., hot-water heating a church, bank building and private residences in Reading.

Campdell Heating Co., Des Moines, Ia., installing a heating plant in the new Christian Church in Kingsley.

Buxton & Allard, Nashua, N. H., steam heating plant for the Pepperell Card & Paper Company; also reconstructing the heating system in the High School at Pepperell, Mass.

Frank Huebsch, Los Angeles, Cal., steam fitting and plumbing an apartment house in Los Angeles.

Robert Gordon, Chicago, Ill., steam heating the new Santa Fe shop building at Topeka, Kan.

Morris & Maloney, Springfield, Mass., heating the fire engine house on Oakland and Dickinson streets.

John A. North, Xenia, Ohio, heating the new school house at Spring Valley.

Korsmeyer Co., Lincoln, Neb., installing the heating and plumbing in the new high school building at Greenwood, Neb.

Eastman & Co., Bridgeport, Conn., heating and plumbing the new Turkish baths and steam heating the Lincoln Building.

Mankato Mfg. Co., Mankato, Minn., installing the heating system in the new Union Block.

George Wigglesworth, Naugatuck, Conn., heating and plumbing the new Polish Church.

Slipp & Gruenhagen Co., Brainerd, Minn., steam heating the new furniture exposition building in St. Paul.

F. A. Clegg & Co., Louisville, Ky., contract for the power equipment of the White City Park in Louisville.

W. W. Patten & Co., Pittsburg, Pa., heating and ventilating the addition to the school house at Elizabeth, Pa.

Enterprise Steam & Hot Water Heating Co., Baltimore, Md., hot water heating the St. Charles' College.

Pawtucket Steam & Gas Pipe Co., Pawtucket, R. I., plumbing and heating the Y. M. C. A. building.

O. F. Doyle, St. Cloud, Minn., installing the heating plant in St. Joseph's Academy.

Warren Machine & Iron Works Co., Warren, Minn., heating a school in Humbolt.

A. B. Franklin, Boston, Mass., installing a central heating plant in the hospital at Clifton.

J. H. Fenton Co., Cedar Rapids, Ia., steam heating a school in Iowa Falls.

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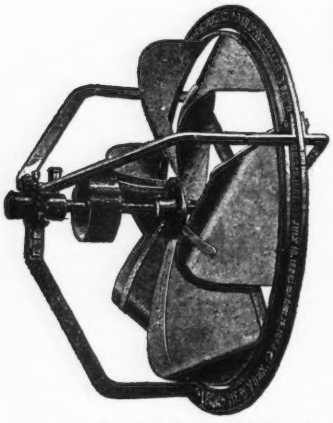

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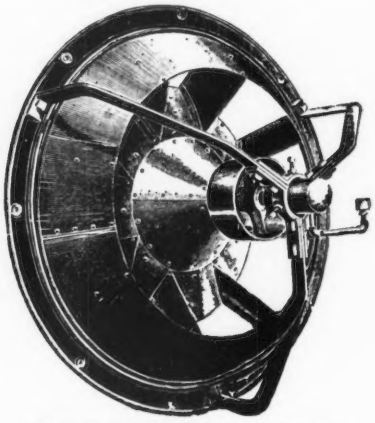

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